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**Tsukahara**

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(45) **Date of Patent: Dec. 28, 2021**

(54) **IMAGE FORMING APPARATUS**

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***G03G 15/08*** (2006.01)

(52) **U.S. Cl.**
CPC ..... ***G03G 15/0808*** (2013.01)

(58) **Field of Classification Search**
CPC ..... G03G 15/0808; G03G 2215/0193; G03G 15/0136
See application file for complete search history.

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(57) **ABSTRACT**

An image forming apparatus includes a first photosensitive drum, a first developing unit including a first developing roller configured to contact the first photosensitive drum, a second photosensitive drum, and a second developing unit including a second developing roller configured to contact the second photosensitive drum. The image forming apparatus includes a first movement mechanism configured to move the first developing unit so that the first developing unit is located at a first contact position and a first separation position, and a second movement mechanism configured to move the second developing unit so that the second developing unit is located at a second contact position, a second separation position, and an intermediate position between the second contact position and the second separation position.

**19 Claims, 11 Drawing Sheets**

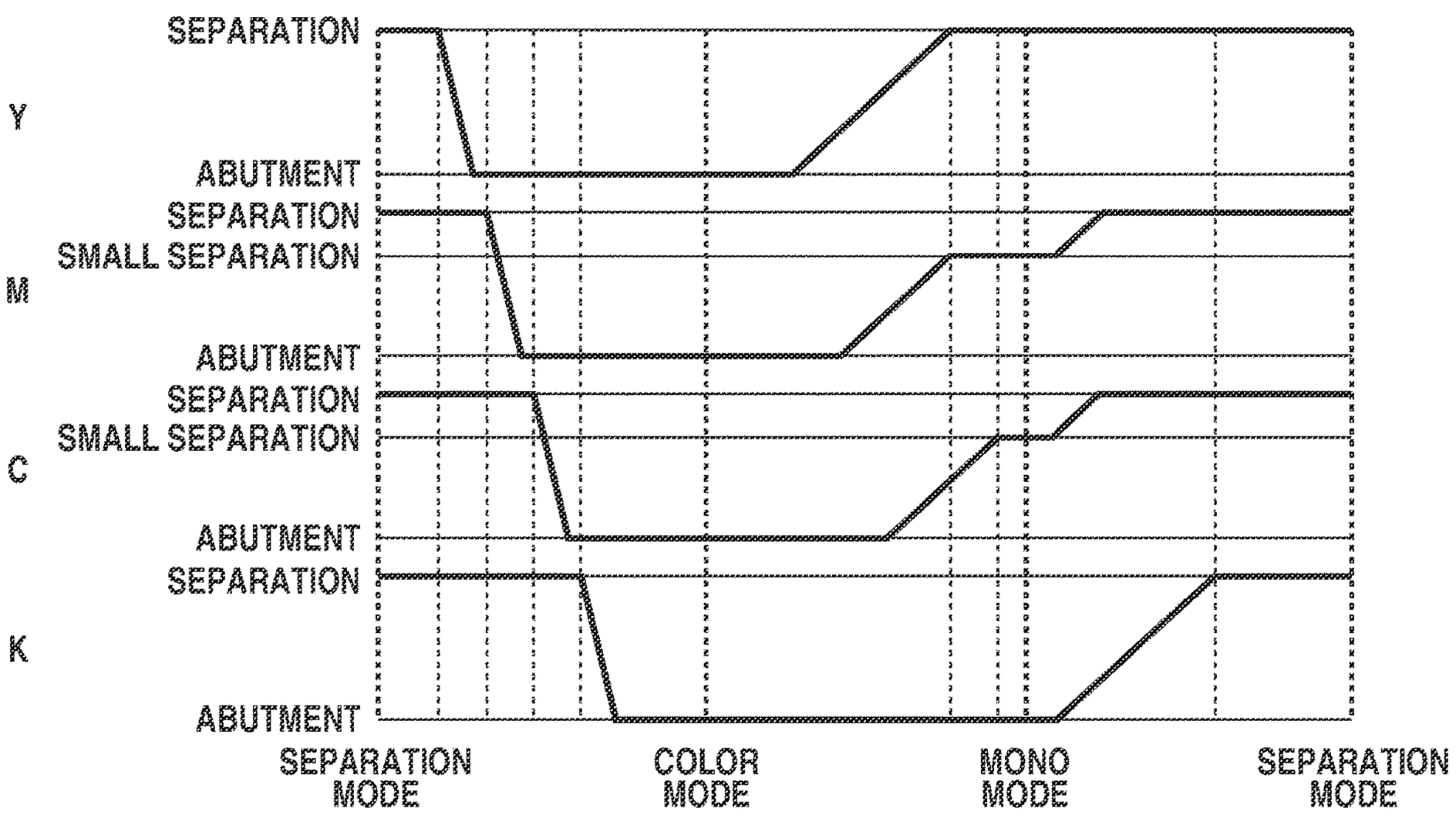
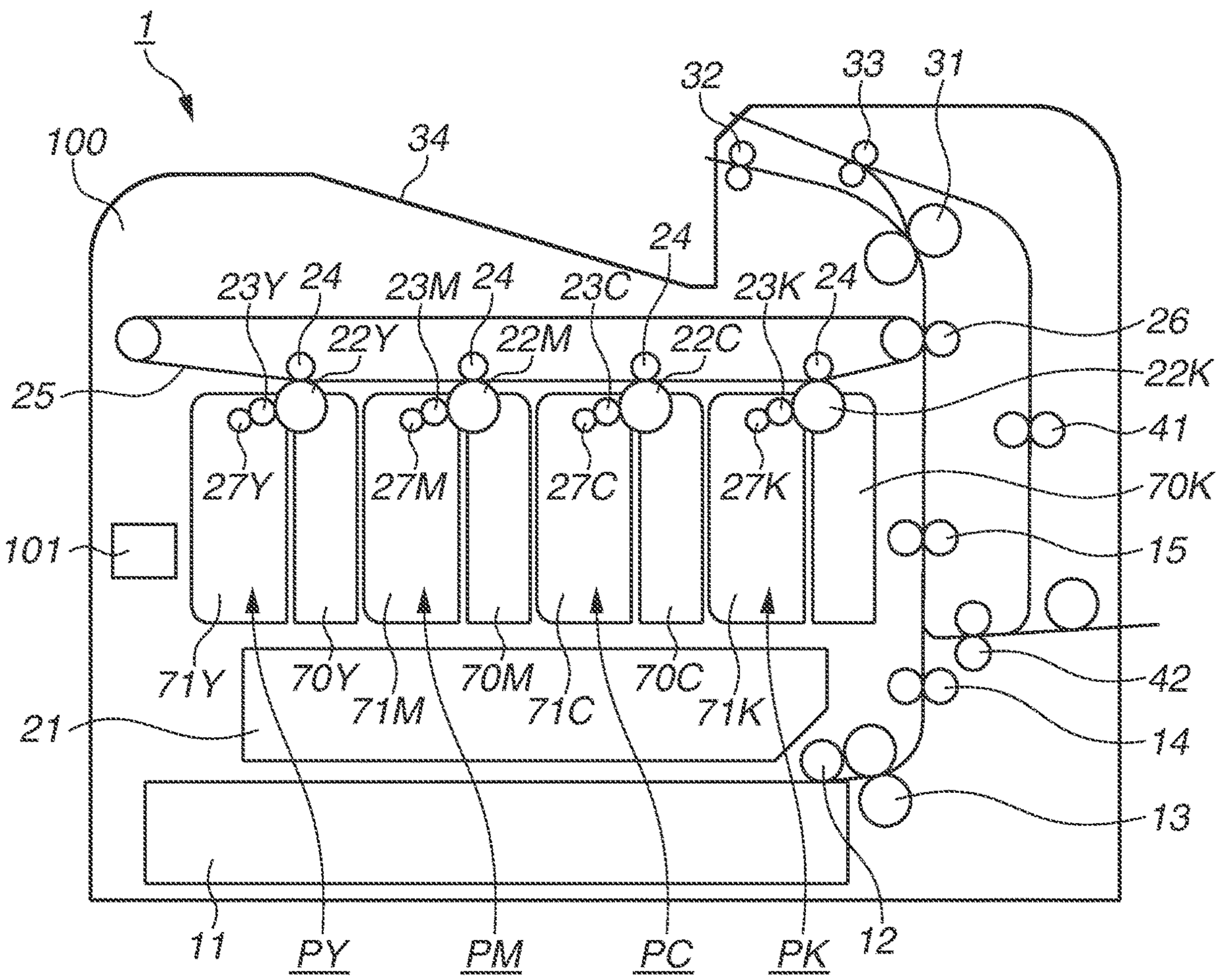


FIG.1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27Y
27M
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27K
70K
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PY
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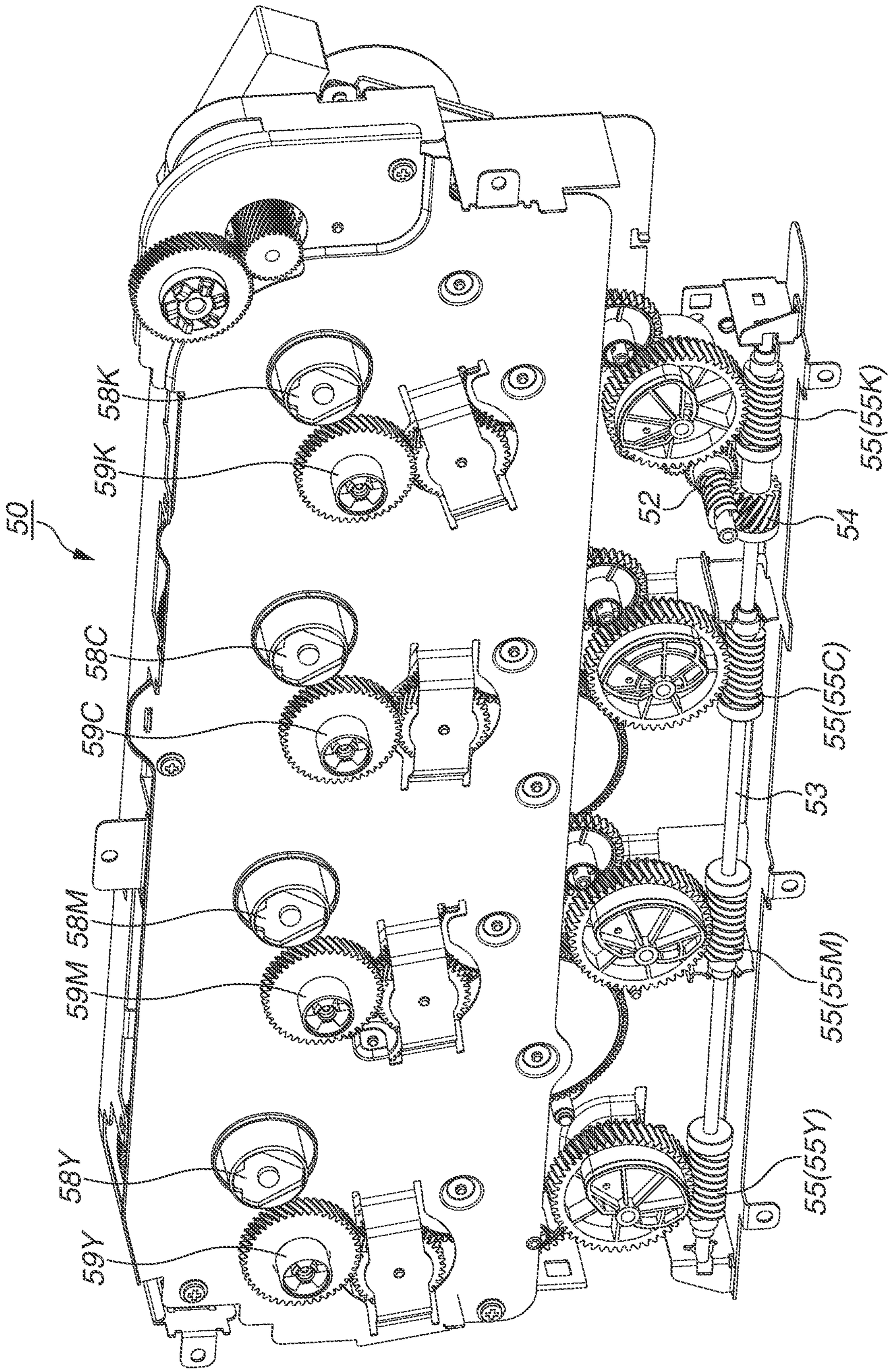
PK
12

FIG.2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59K
58K
59C
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58Y
52
54
53
55(55K)
55(55C)
55(55M)
55(55Y)

FIG.3A

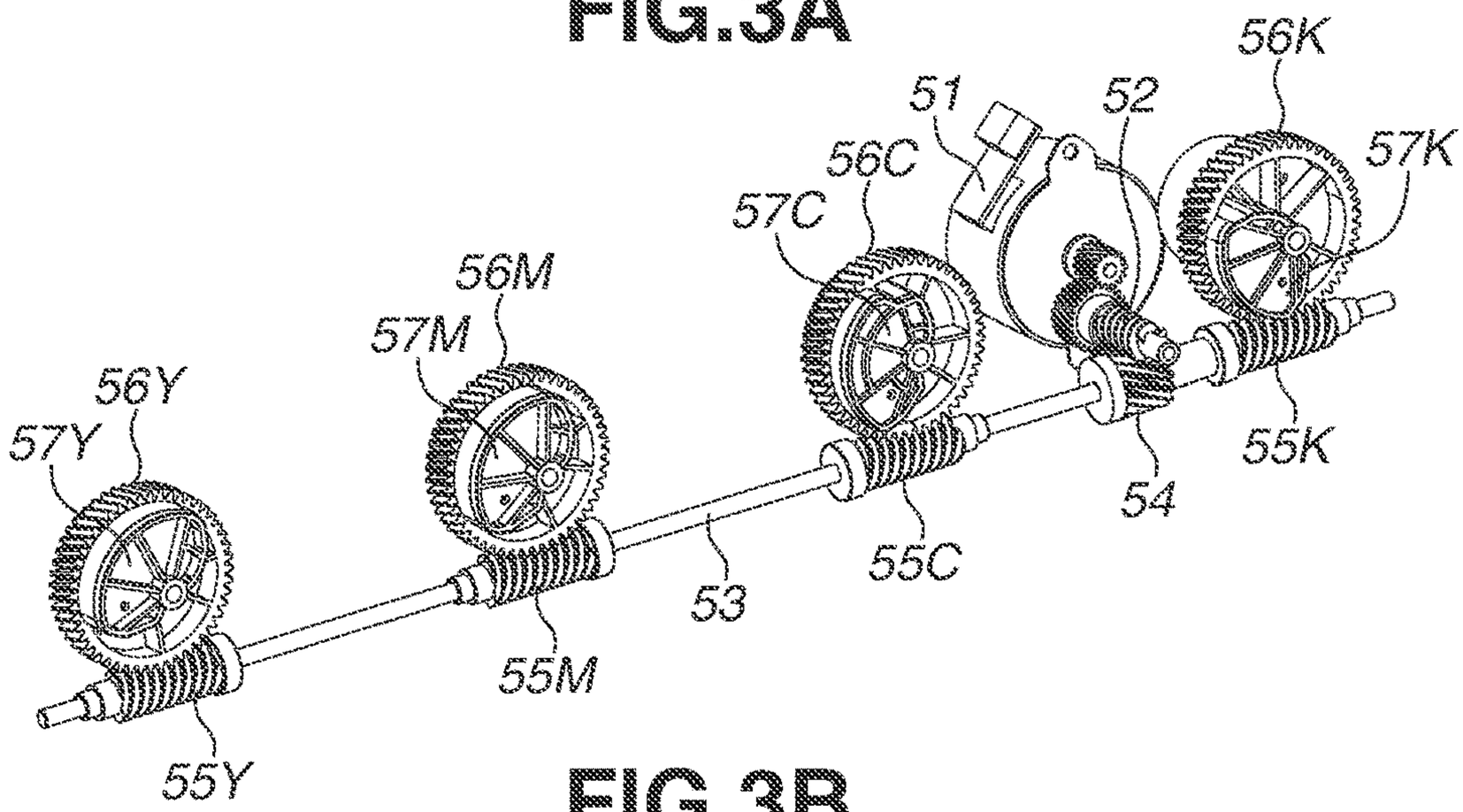



FIG.3B

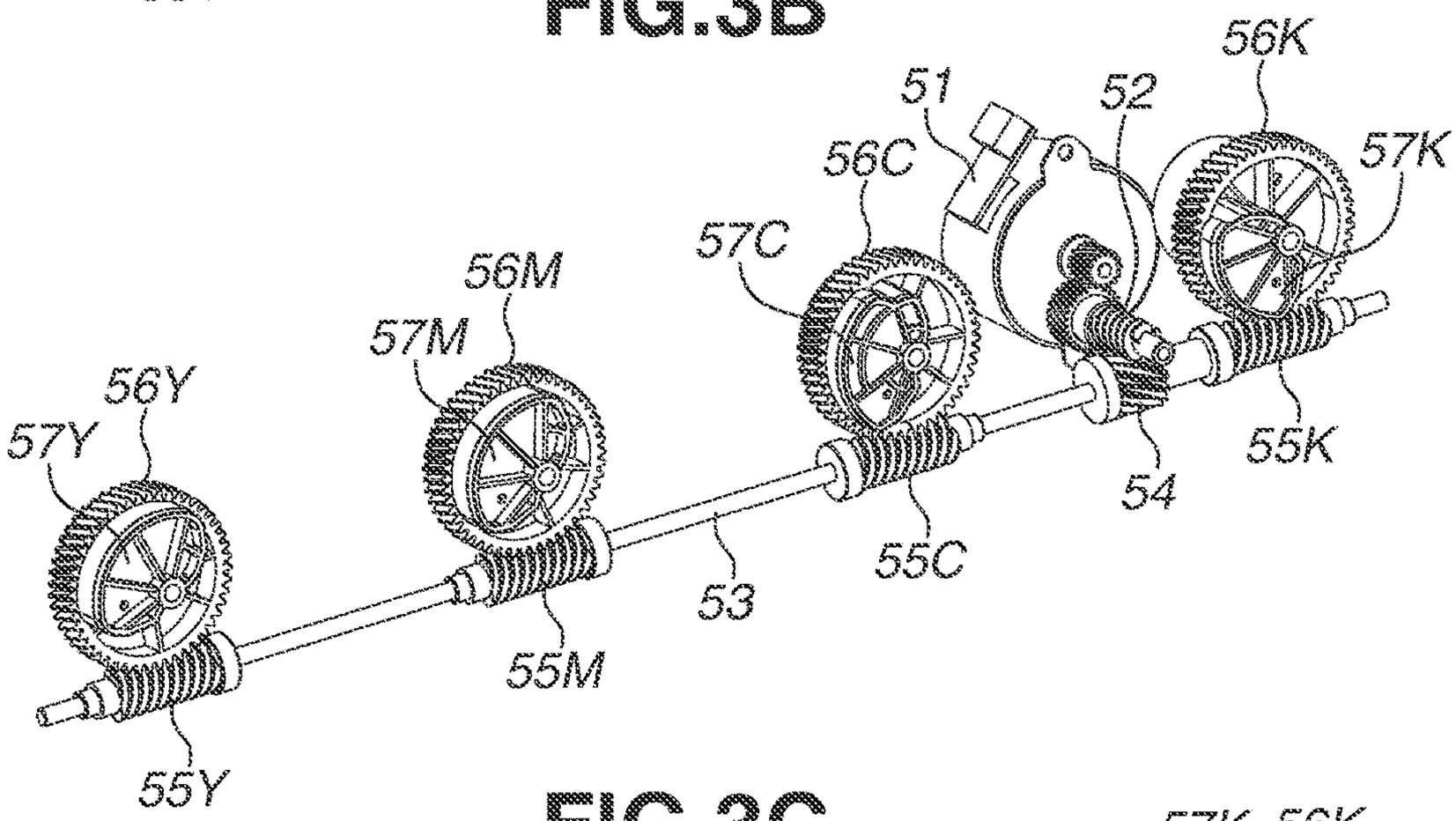



FIG.3C

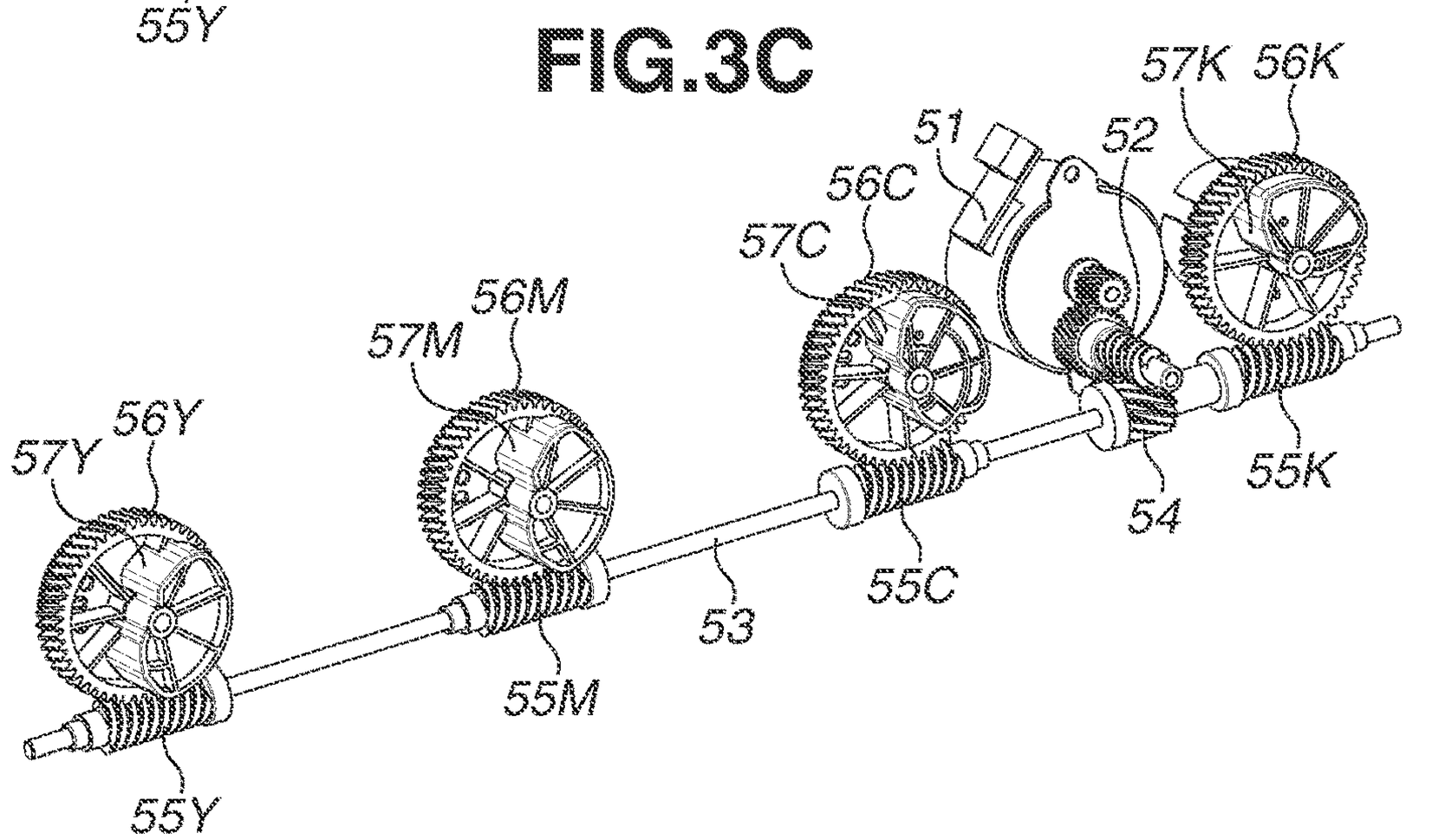


FIG.4A

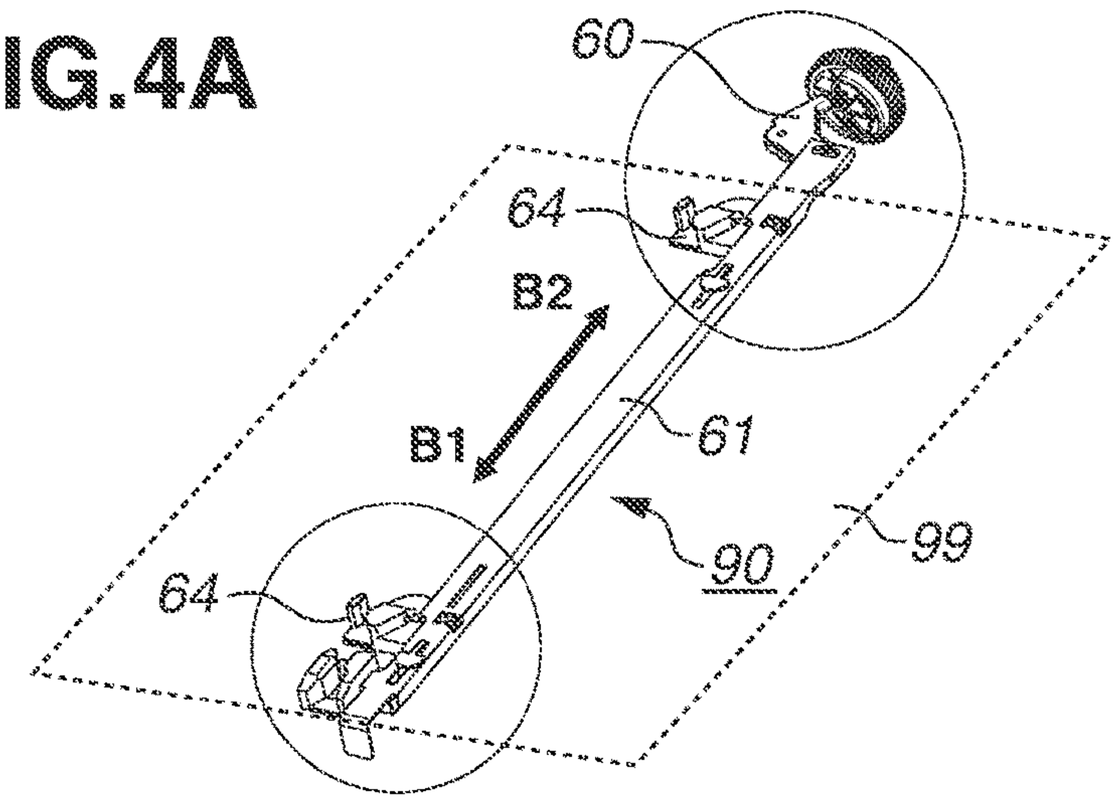



FIG.4B

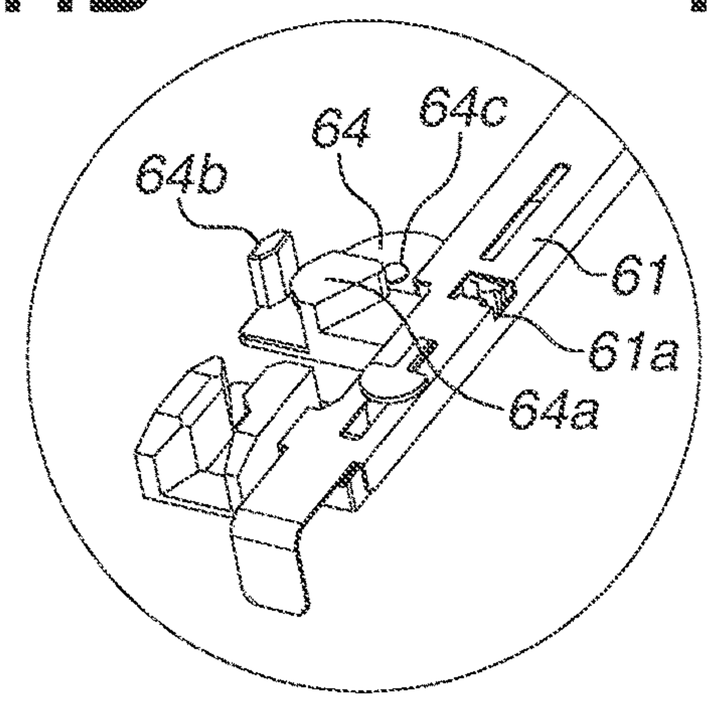



FIG.4C

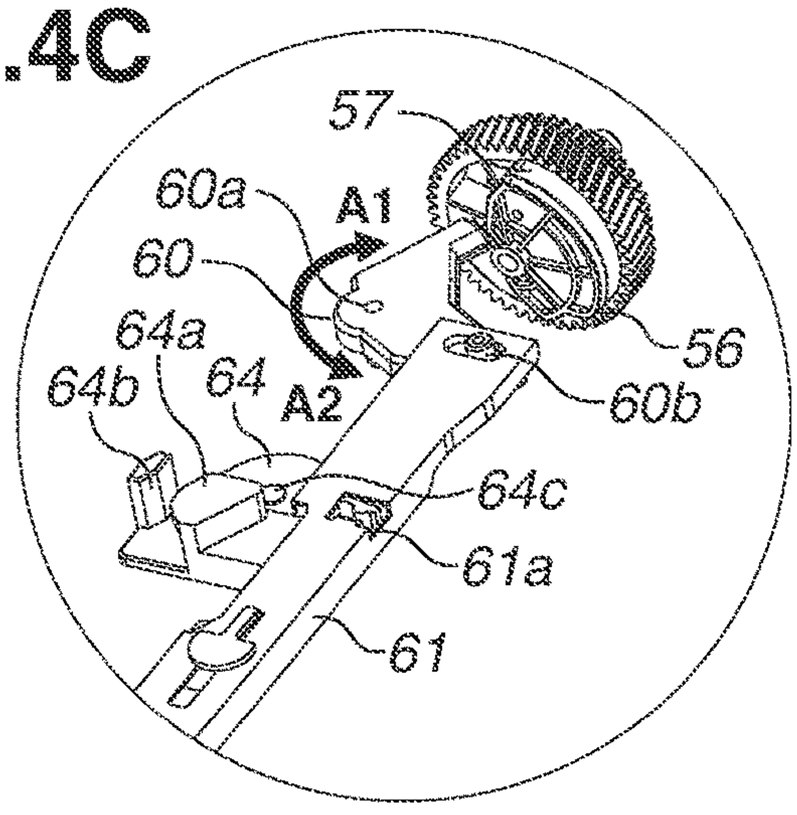



FIG.4D

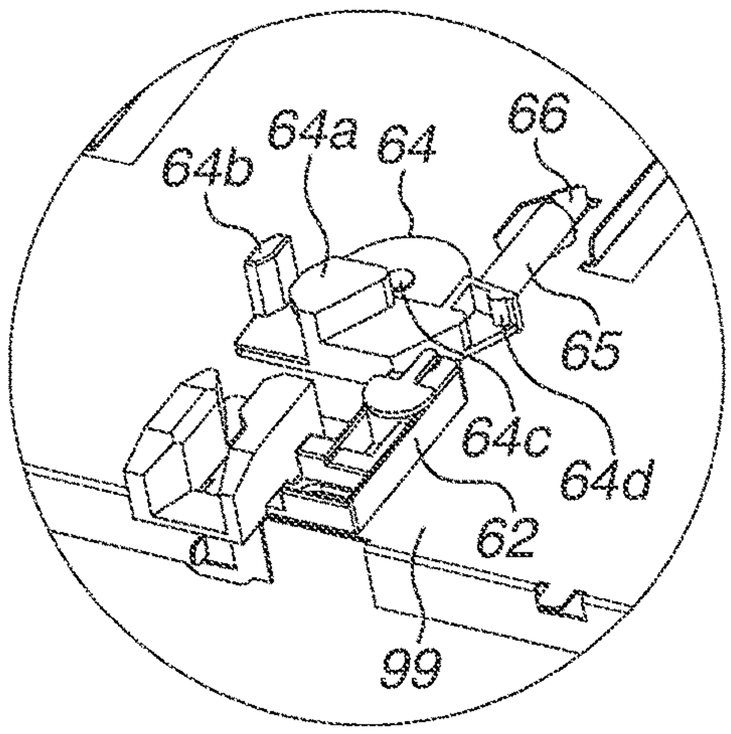



FIG.4E

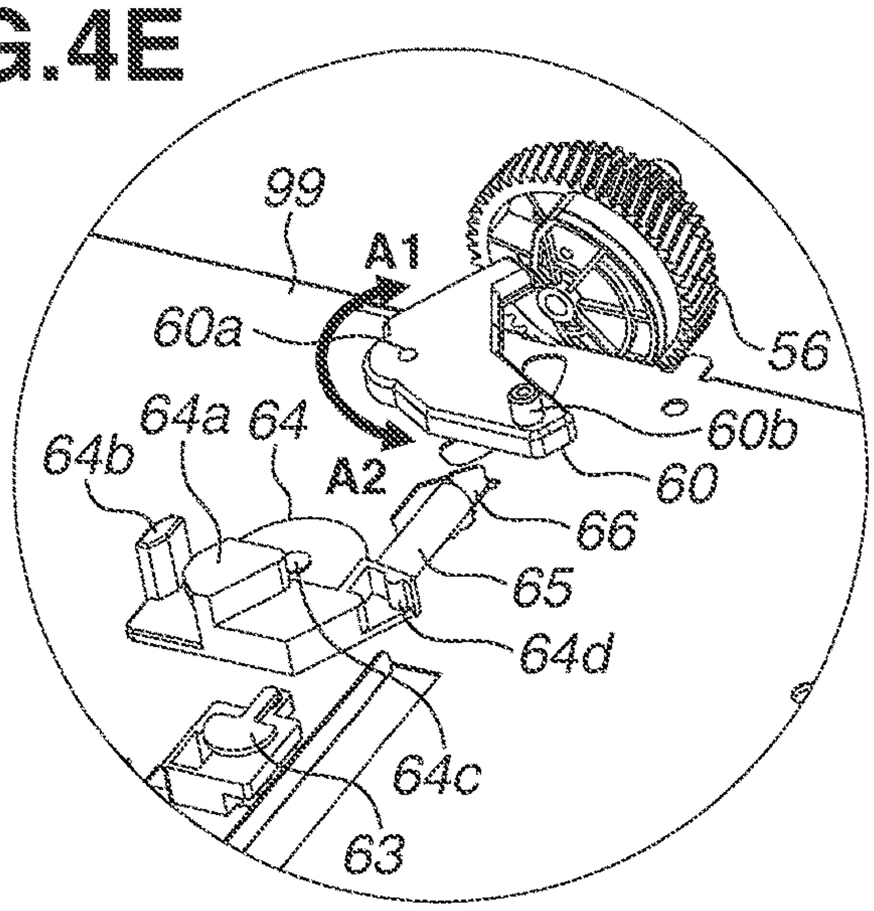


FIG.5C

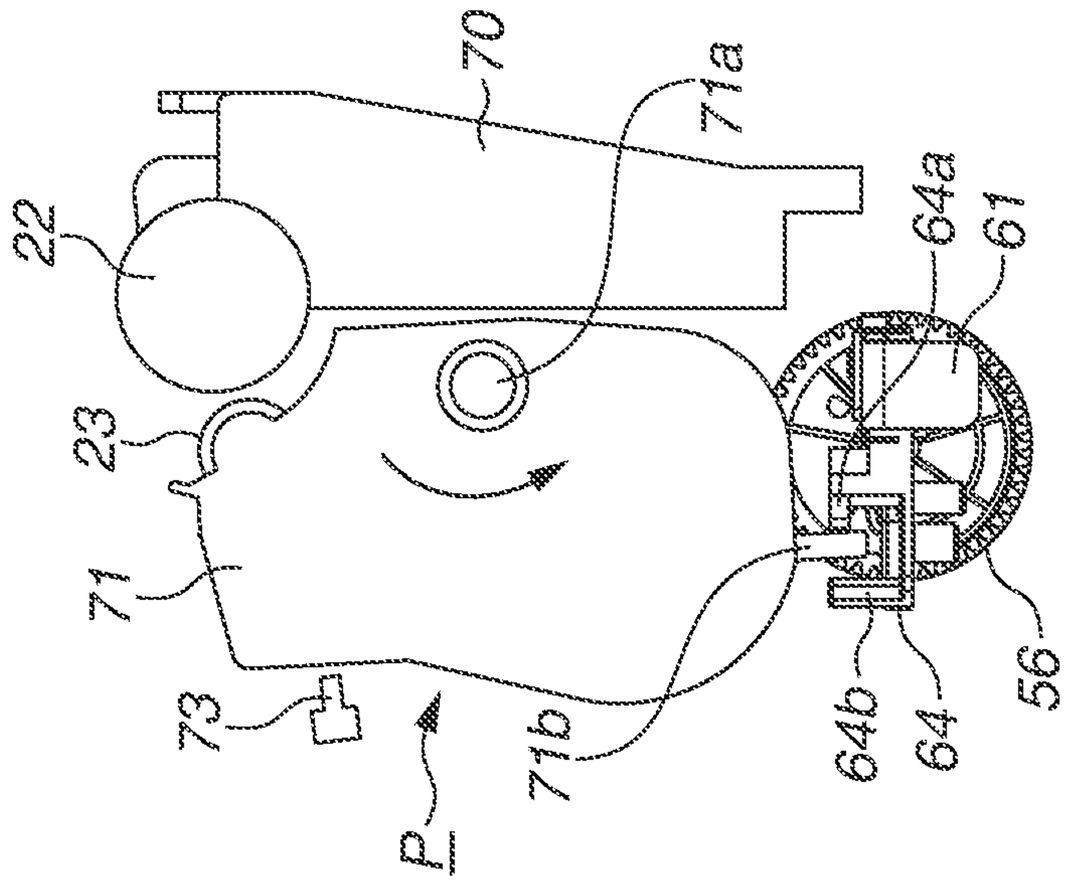



FIG.5B

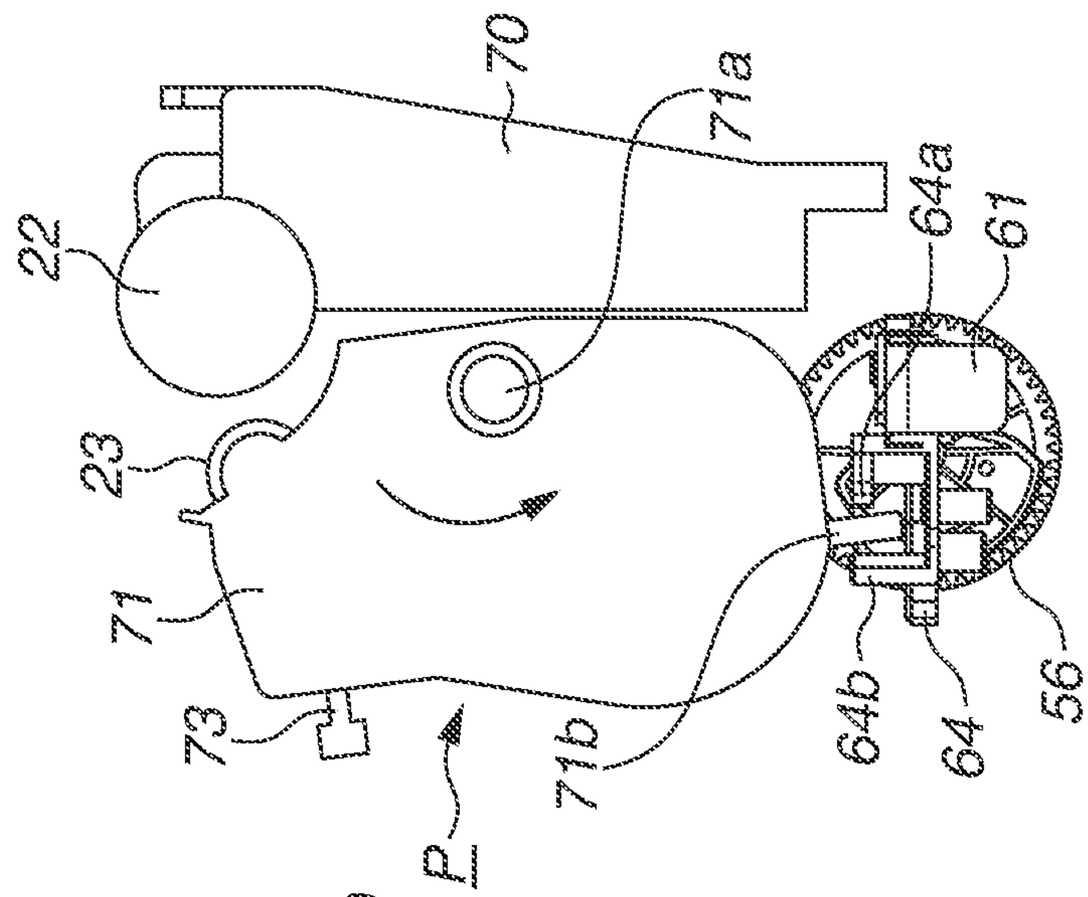



FIG.5A

FIG.6A

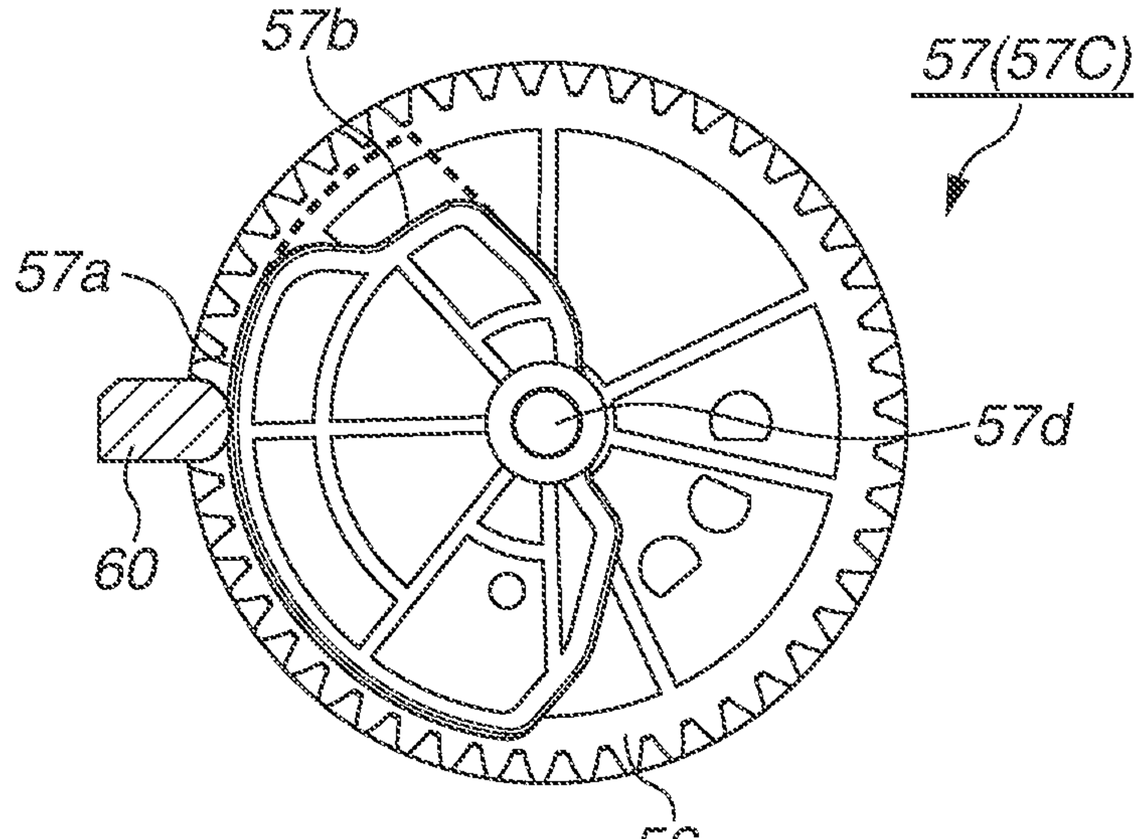



FIG.6B

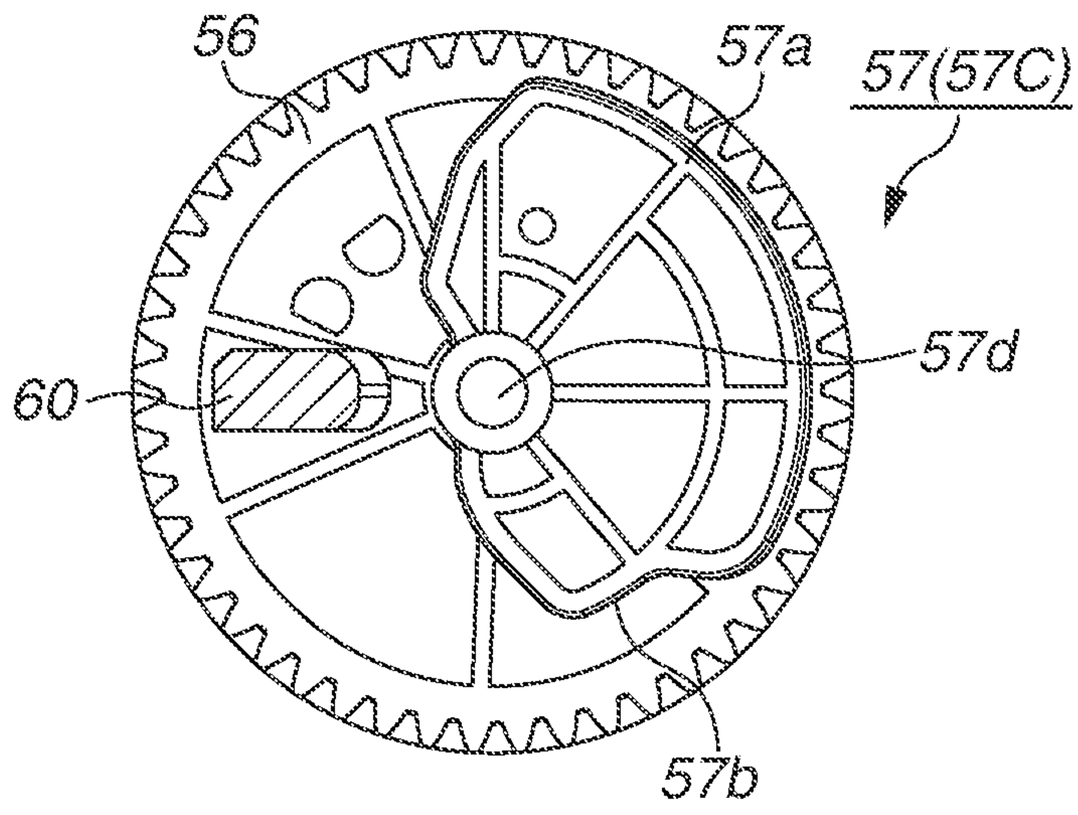



FIG.6C

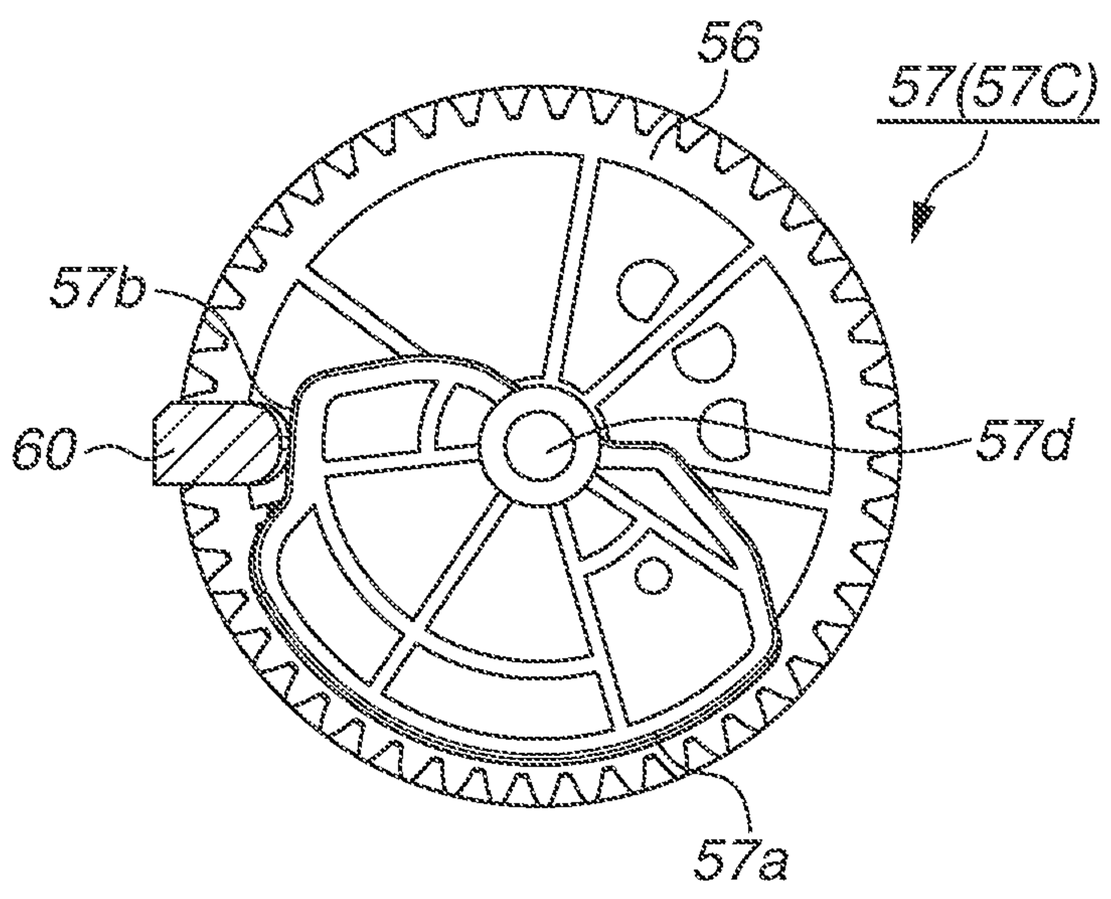
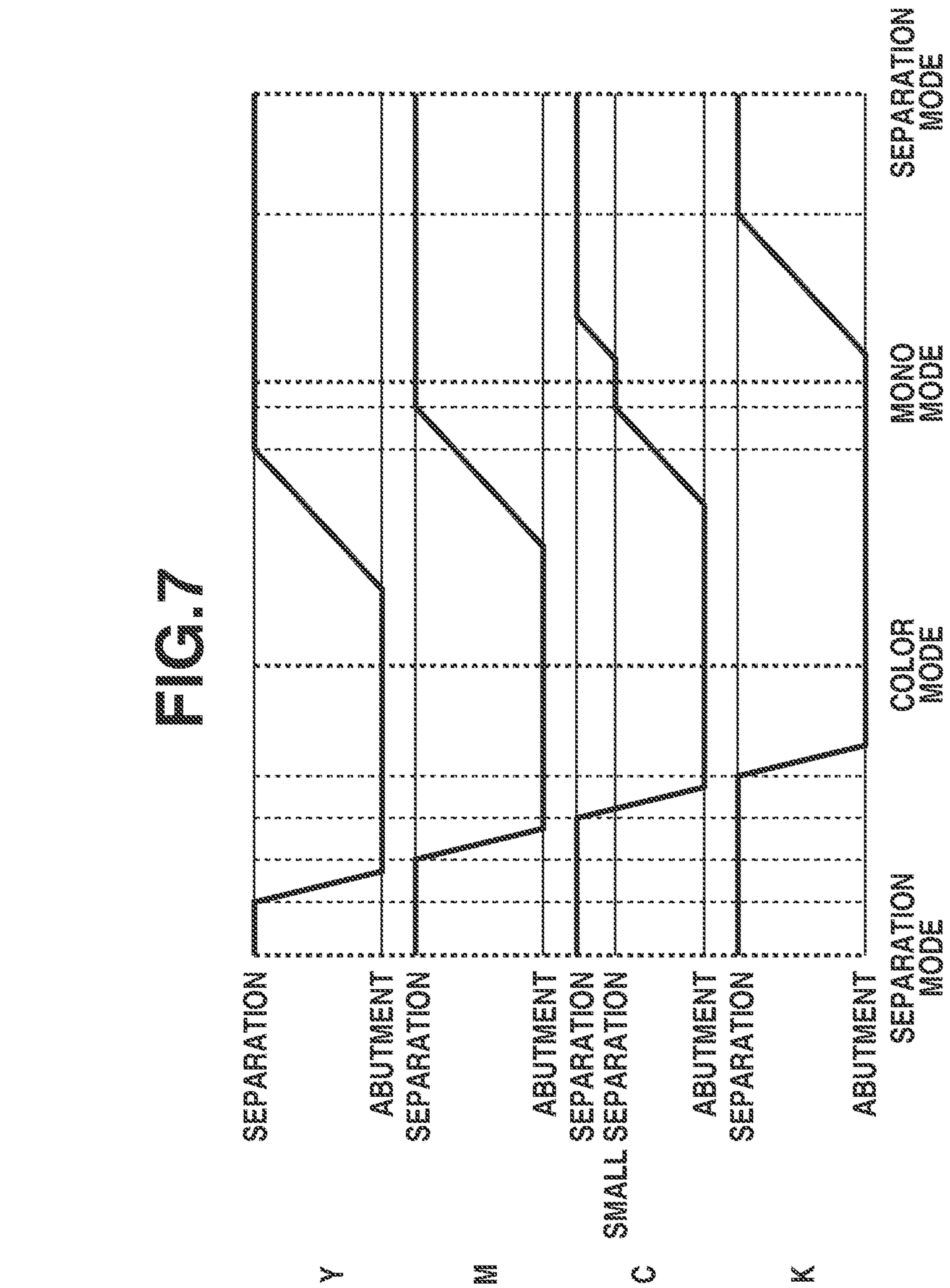


FIG.7


Y
SEPARATION
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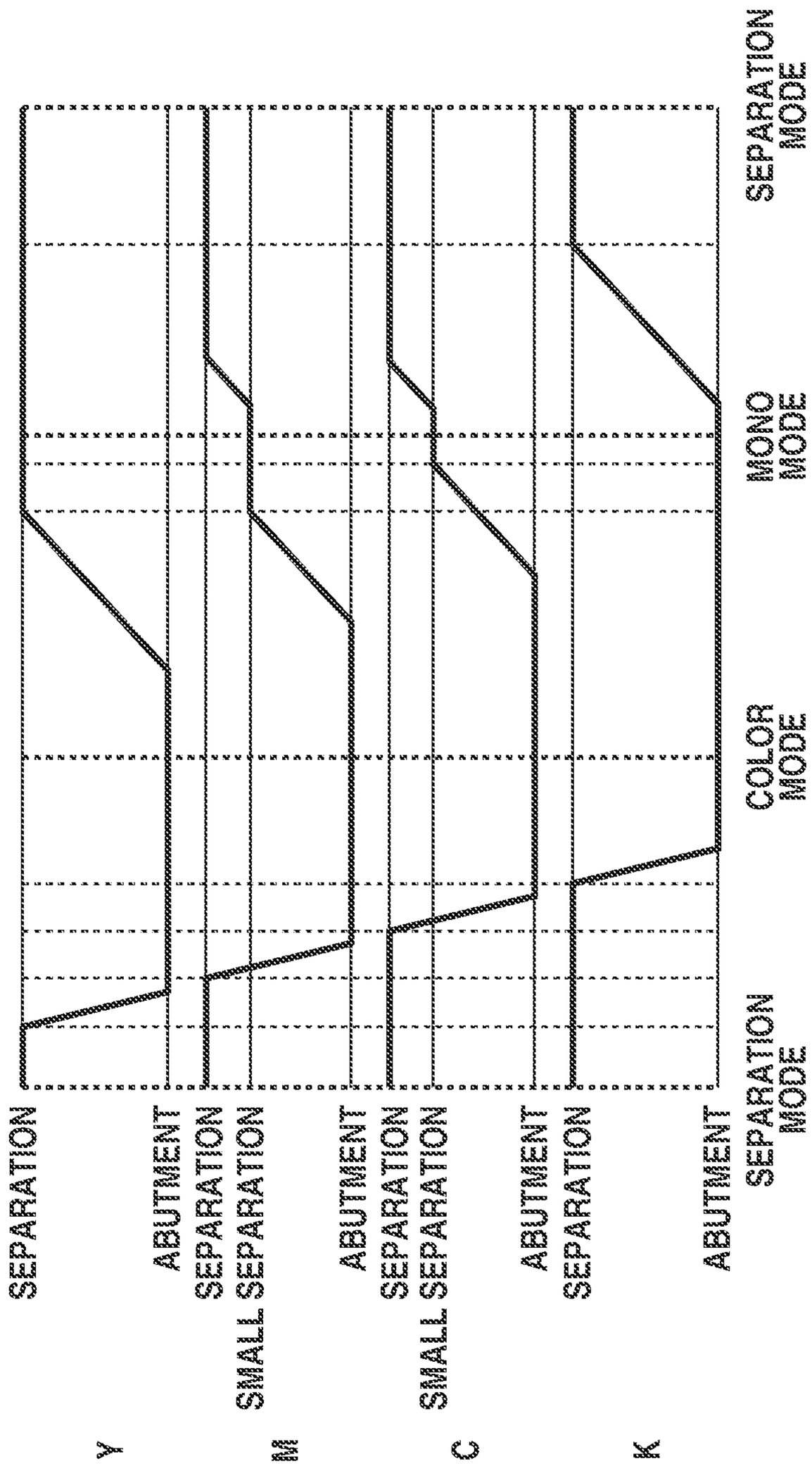
SEPARATION
M
ABUTMENT
SEPARATION
SMALL SEPARATION
C
ABUTMENT
SEPARATION
K
ABUTMENT
SEPARATION
COLOR MODE
MONO MODE
SEPARATION MODE

FIG.8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ABUTMENT

FIG.9

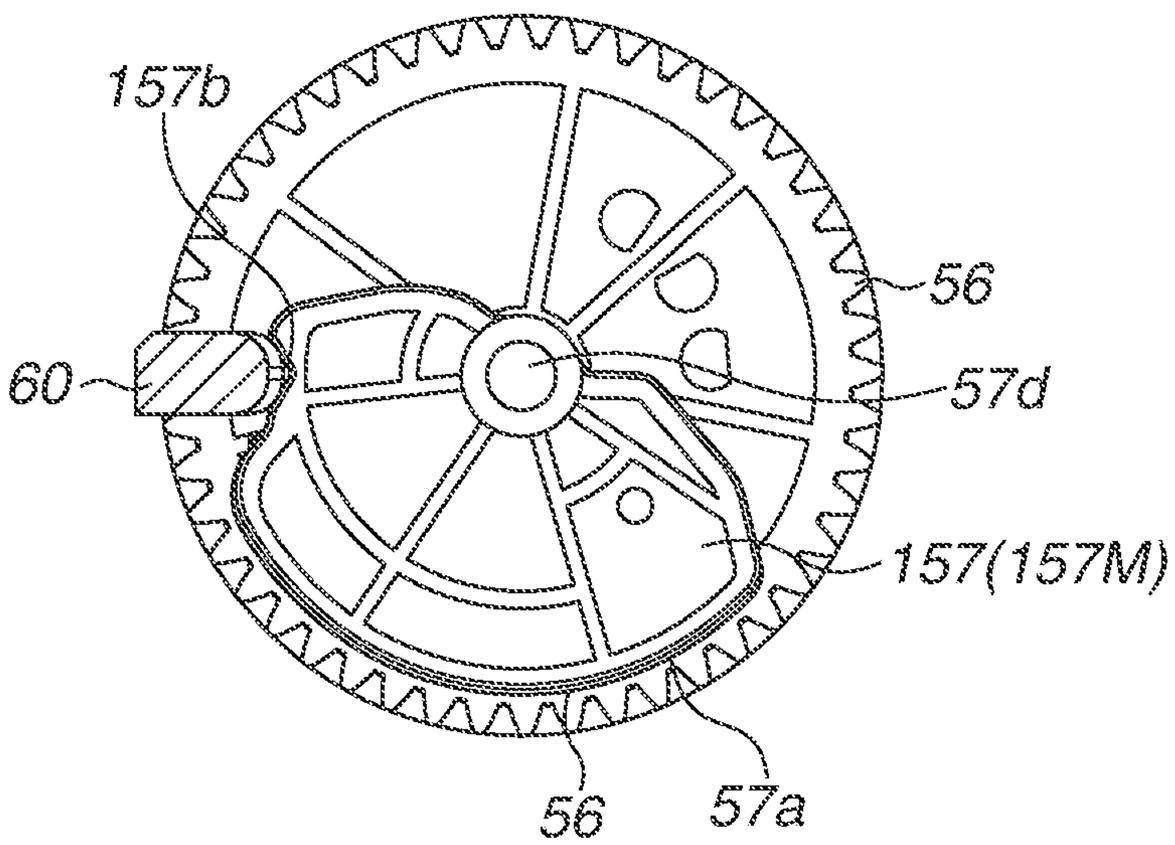


FIG.10C

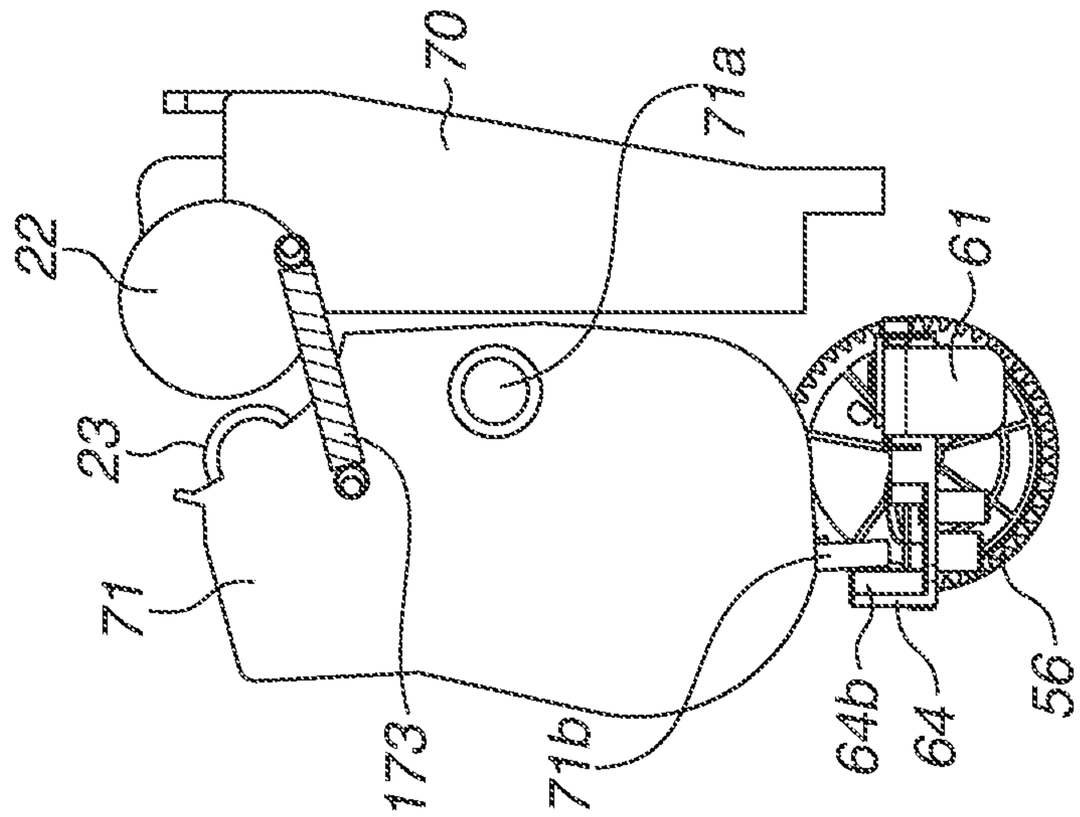



FIG.10B

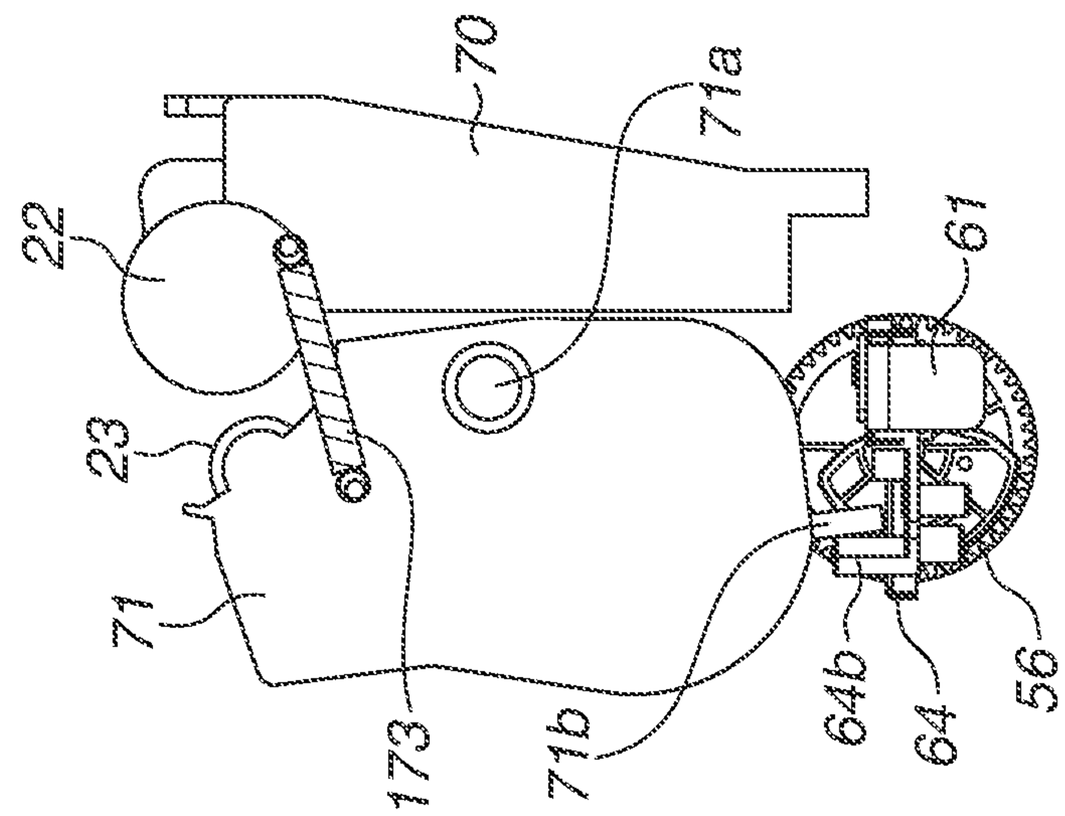



FIG.10A

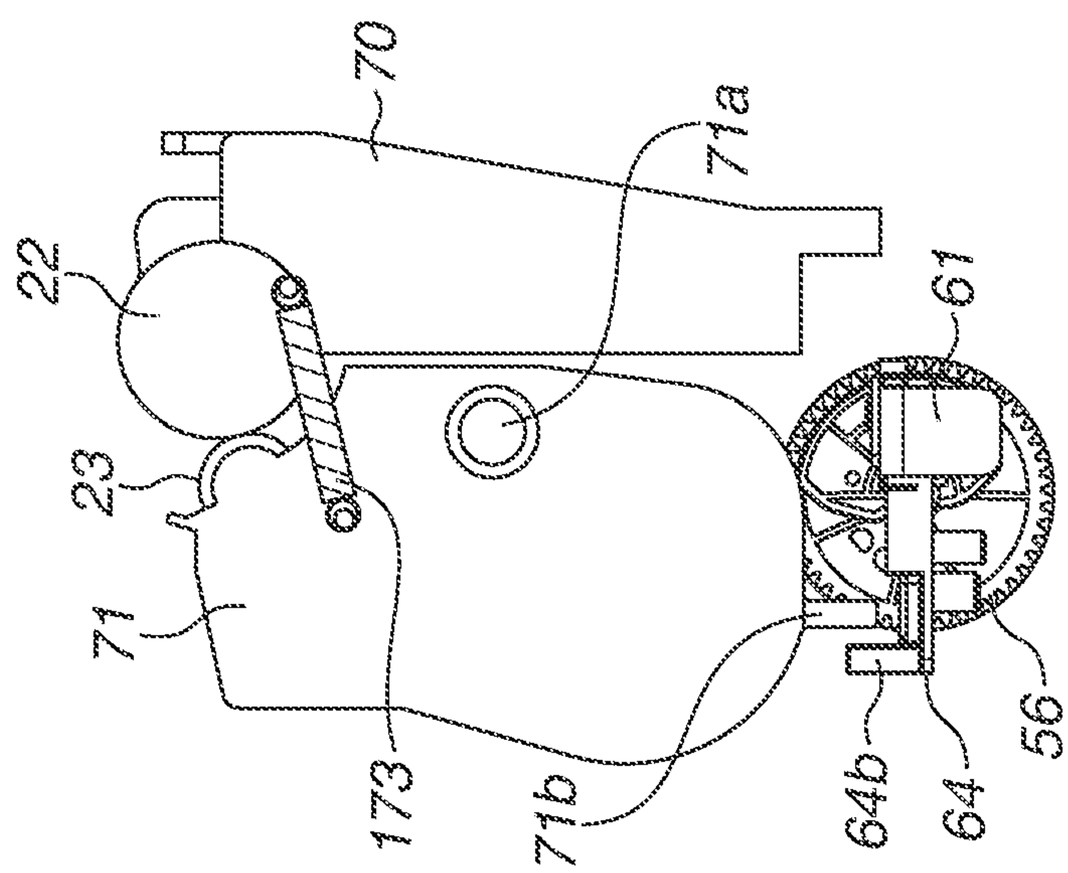
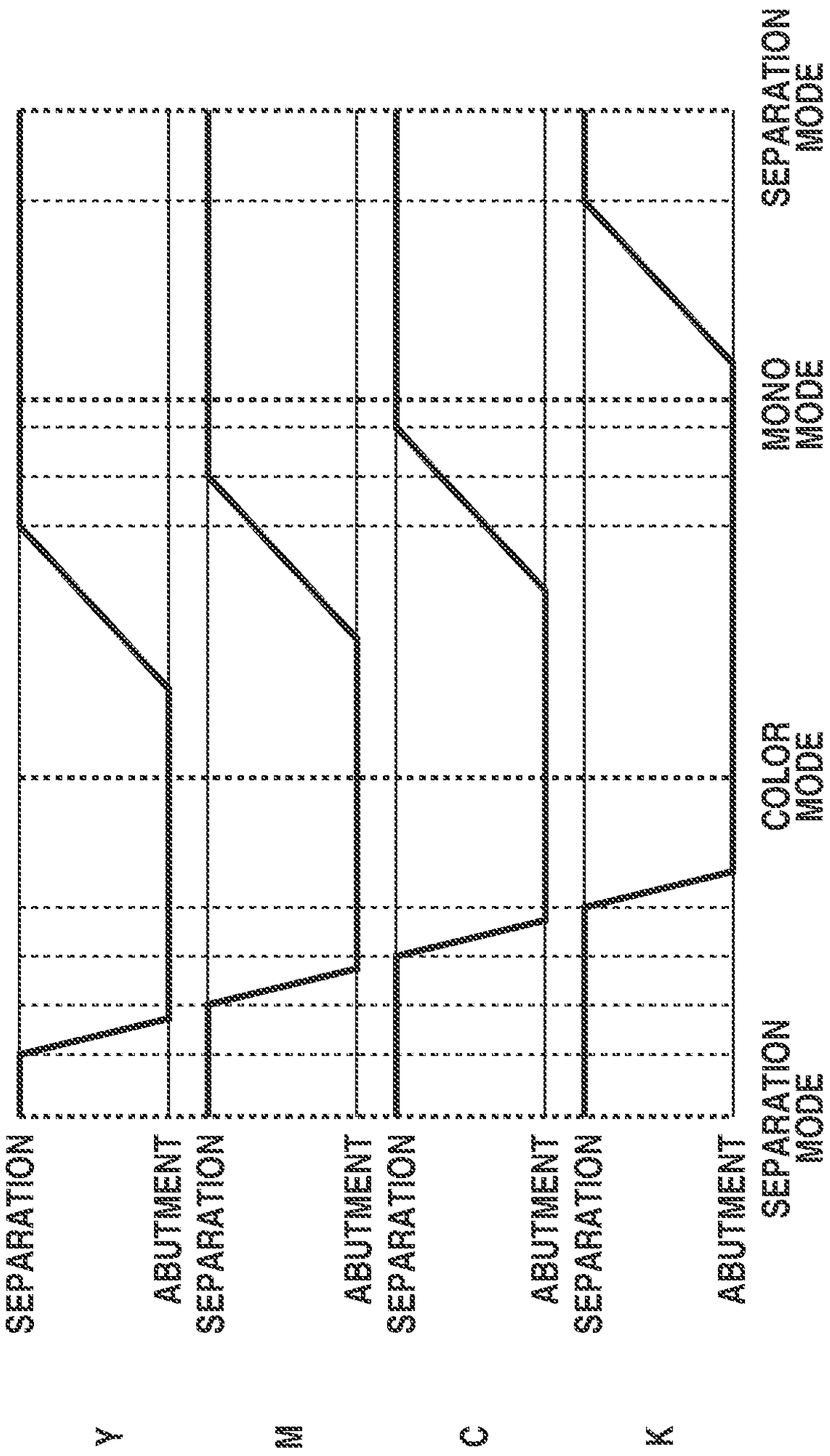


FIG. 11


Y
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SEPARATION
ABUTMENT
SEPARATION MODE
MONO MODE
COLOR MODE
SEPARATION MODE

# IMAGE FORMING APPARATUS

## BACKGROUND

### Field of the Disclosure

The present disclosure generally relates to an image forming apparatus using an electrophotographic method.

### Description of the Related Art

Examples of an image forming apparatus include an electrophotographic copying machine, an electrophotographic printer (e.g., light-emitting diode (LED) printer and laser beam printer), a facsimile machine, and a word processor.

An image forming apparatus using a contact development method for performing development in a state where a developing roller as a developer bearing member is in contact with a photosensitive drum as a photosensitive member is known. In a case where the contact development method is used, the developing roller and the photosensitive drum are separated from each other except when an image is formed, whereby it is possible to reduce the wearing away of the photosensitive drum and the deterioration of the developing roller.

Japanese Patent Application Laid-Open No. 2012-234205 discusses an image forming apparatus capable of forming a full-color image using first to fourth cartridges. Further, the image forming apparatus discussed in Japanese Patent Application Laid-Open No. 2012-234205 can form a monocolor image in a state where a photosensitive drum and a developing roller contact each other in one of the cartridges, and a photosensitive drum is separate from a developing roller in each of the other cartridges. In other words, the image forming apparatus discussed in Japanese Patent Application Laid-Open No. 2012-234205 can perform an image forming operation using one or some of the cartridges (image forming units).

## SUMMARY

The present disclosure is further developed from the conventional technique. The present disclosure is directed to providing an image forming apparatus capable of executing an image forming operation using one or more of the image forming units, and shortening the time during which the state where a developing roller and a photosensitive drum contact each other is maintained.

According to an aspect of the present disclosure, an image forming apparatus includes a first image forming unit having a first drum unit including a first photosensitive drum, and a first developing unit including a first developing roller configured to contact the first photosensitive drum, a second image forming unit having a second drum unit including a second photosensitive drum, and a second developing unit including a second developing roller configured to contact the second photosensitive drum, a first movement mechanism configured to move the first developing unit so that the first developing unit is located at a first contact position where the first developing roller contacts the first photosensitive drum, and a first separation position where the first developing roller is separate from the first photosensitive drum, a second movement mechanism configured to move the second developing unit so that the second developing unit is located at a second contact position where the second developing roller contacts the second photosensitive drum, a second separation position where the second developing roller is separate from the second photosensitive drum, and an intermediate position between the second contact position and the second separation position, and a control unit configured to execute a first image forming operation in a state where the first developing roller contacts the first photosensitive drum, and the second developing roller is separate from the second photosensitive drum, wherein the first movement mechanism is configured to start moving the first developing unit from the first contact position to the first separation position in a state where the second developing unit is located between the second contact position and the second separation position.

Further features of the present disclosure will become apparent from the following description of exemplary embodiments with reference to the attached drawings.



## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view schematically illustrating a configuration of an image forming apparatus.

FIG. **2** is a perspective view of a main driving unit.

FIGS. **3**A, **3**B, and **3**C are perspective views respectively illustrating the main driving unit in a separation mode, the main driving unit in a color mode, and the main driving unit in a mono mode.

FIG. **4**A is an overall perspective view of a movement unit, and FIGS. **4**B, **4**C, **4**D and **4**E are partial enlarged views respectively illustrating one end side of the movement unit (front side of apparatus main body), the other end side of the movement unit (back side of apparatus main body), the one end side of the movement unit in a state where a slider is omitted, and the other end side of the movement unit (back side of apparatus main body) in the state where the slider is omitted.

FIGS. **5**A, **5**B, **5**C are side views respectively illustrating a process cartridge in a state where a developing unit is in an contact state, the process cartridge in a state where the developing unit is in a separation state, and the process cartridge in a state where the developing unit is in an intermediate state (small separation state).

FIGS. **6**A, **6**B, **6**C are diagrams respectively illustrating a relationship between a cam portion and a lever in the separation state, the relationship between the cam portion and the lever in the contact state, and the relationship between the cam portion and the lever in the small separation state.

FIG. **7** is a cam diagram illustrating an operation of the image forming apparatus according to a first exemplary embodiment.

FIG. **8** is a cam diagram illustrating an operation of an image forming apparatus according to a second exemplary embodiment.

FIG. **9** is a diagram illustrating a relationship between a cam portion and a lever according to the second exemplary embodiment.

FIGS. **10**A, **10**B, and **10**C are side views respectively illustrating a process cartridge in a state where a developing unit is in a contact state, the process cartridge in a state where the developing unit is in a separation state, and the process cartridge in a state where the developing unit is in an intermediate state.

FIG. **11** is a cam diagram illustrating an operation of an image forming apparatus according to a comparative example.

## DESCRIPTION OF THE EMBODIMENTS

With reference to the drawings, example configurations according to the present disclosure will be described. In

principle, dimensions, materials, shapes, and arrangements of components described in exemplary embodiments should be appropriately changed according to the configuration of an apparatus to which the present disclosure is applied, and various conditions.

<Overall Configuration of Image Forming Apparatus>

A first exemplary embodiment is described. With reference to FIG. **1**, an overall configuration of an image forming apparatus **1** is described.

FIG. **1** is a cross-sectional view schematically illustrating the configuration of the image forming apparatus **1**.

The image forming apparatus **1** can form a full-color image and a mono-color image. The image forming apparatus **1** is a laser beam printer using a scanner **21** as an exposure apparatus. The present disclosure can also be applied to an exposure apparatus other than the scanner **21**, such as a so-called light-emitting diode (LED) printer using a light-emitting diode.

The image forming apparatus **1** includes an apparatus main body **100**. In a lower portion of the apparatus main body **100**, a cassette **11** that stores a recording material such as paper is arranged. The cassette **11** is configured to be inserted into and removed from the apparatus main body **100**. The recording material stored in the cassette **11** is taken out of the cassette **11** by a pickup roller **12** and a sheet feeding roller **13**. The recording material taken out of the cassette **11** is conveyed by conveyance roller pairs **14** and **15** to a secondary transfer roller **26** that forms a secondary transfer unit. The conveyance roller pair **15** has a function of registration rollers that adjust the conveying direction of the recording material.

The apparatus main body **100** includes four process cartridges P as image forming units. More specifically, process cartridges PY, PM, PC, and PK are attached to the apparatus main body **100**. Each process cartridge P (PY, PM, PC, PK) is configured to be attached to and detached from the apparatus main body **100**. The process cartridge PY is adjacent to the process cartridge PM. The process cartridge PM is adjacent to the process cartridge PC. The process cartridge PC is adjacent to the process cartridge PK.

Each process cartridge P (PY, PM, PC, PK) includes a photosensitive drum **22** (**22**Y, **22**M, **22**C, **22**K) equivalent to an image bearing member or a photosensitive member, and a developing roller **23** (**23**Y, **23**M, **23**C, **23**K) equivalent to a developer bearing member. The process cartridge P (PY, PM, PC, PK) includes a supply roller **27** (**27**Y, **27**M, **27**C, **27**K) that comes into contact with the developing roller **23** (**23**Y, **23**M, **23**C, **23**K) and supplies toner. The process cartridge P (PY, PM, PC, PK) includes a charging member (not illustrated) that charges the photosensitive drum **22** (**22**Y, **22**M, **22**C, **22**K).

The process cartridge PY is an image forming unit (fourth image forming unit) that forms a yellow image. The process cartridge PY includes a photosensitive unit (fourth photosensitive unit, fourth drum unit) **70**Y including the photosensitive drum (fourth photosensitive drum) **22**Y. The process cartridge PY includes a developing unit (fourth developing unit) **71**Y including the developing roller (fourth developing roller) **23**Y that can contact the photosensitive drum **22**Y, and the supply roller **27**Y. To develop an electrostatic latent image on the photosensitive drum **22**Y, the developing unit **71**Y stores yellow toner. The developing unit **71**Y is configured to be movable relative to the photosensitive unit **70**Y between a contact position where the developing roller **23**Y contacts the photosensitive drum **22**Y, and a separation position where the developing roller **23**Y separates from the photosensitive drum **22**Y.

The process cartridge PM is an image forming unit (third image forming unit) that forms a magenta image. The process cartridge PM includes a photosensitive unit (third photosensitive unit, third drum unit) **70**M including the photosensitive drum (third photosensitive drum) **22**M. The process cartridge PM includes a developing unit (third developing unit) **71**M including the developing roller (third developing roller) **23**M that can contact the photosensitive drum **22**M, and the supply roller **27**M. To develop an electrostatic latent image on the photosensitive drum **22**M, the developing unit **71**M stores magenta toner. The developing unit **71**M is configured to be movable relative to the photosensitive unit **70**M between a contact position where the developing roller **23**M contacts the photosensitive drum **22**M, and a separation position where the developing roller **23**M separates from the photosensitive drum **22**M.

The process cartridge PC is an image forming unit (second image forming unit) that forms a cyan image. The process cartridge PC includes a photosensitive unit (second photosensitive unit, second drum unit) **70**C including the photosensitive drum (second photosensitive drum) **22**C. The process cartridge PC includes a developing unit (second developing unit) **71**C including the developing roller (second developing roller) **23**C that can contact the photosensitive drum **22**C, and the supply roller **27**C. To develop an electrostatic latent image on the photosensitive drum **22**C, the developing unit **71**C stores cyan toner. The developing unit **71**C is configured to be movable relative to the photosensitive unit **70**C between a contact position where the developing roller **23**C contacts the photosensitive drum **22**C, and a separation position where the developing roller **23**C separates from the photosensitive drum **22**C.

The process cartridge PK is an image forming unit (first image forming unit) that forms a black image. The process cartridge PK includes a photosensitive unit (first photosensitive unit, first drum unit) **70**K including the photosensitive drum (first photosensitive drum) **22**K. The process cartridge PK includes a developing unit (first developing unit) **71**K including the developing roller (first developing roller) **23**K that can contact the photosensitive drum **22**K, and the supply roller **27**K. To develop an electrostatic latent image on the photosensitive drum **22**K, the developing unit **71**K stores black toner. The developing unit **71**K is configured to be movable relative to the photosensitive unit **70**K between a contact position where the developing roller **23**K contacts the photosensitive drum **22**K, and a separation position where the developing roller **23**K separates from the photosensitive drum **22**K.

The names "first image forming unit", "second image forming unit", "third image forming unit", and "fourth image forming unit" are designated for convenience to distinguish members.

The signs "Y", "M", "C", and "K" mean the colors (yellow, magenta, cyan, and black) of images to be formed by the respective process cartridges P (PY, PM, PC, PK). In the present exemplary embodiment, the configurations of the respective process cartridges P (PY, PM, PC, PK) are the same as each other except for the colors of the stored toner. In the following description, unless it is particularly necessary to distinguish colors, the above signs will sometimes be omitted.

The apparatus main body **100** includes the scanner **21** as an exposure apparatus that exposes the photosensitive drum **22** (**22**Y, **22**M, **22**C, **22**K) with light. When an image forming operation is performed, the scanner **21** emits laser light to the photosensitive drum **22** (**22**Y, **22**M, **22**C, **22**K) charged by the charging member. With this operation, an

electrostatic latent image is formed on the photosensitive drum **22** (**22**Y, **22**M, **22**C, **22**K).

As described above, each process cartridge P (PY, PM, PC, PK) stores toner corresponding to the color of an image to be formed. In the present exemplary embodiment, non-magnetic monocomponent toner is used. The toner is supplied to the developing roller **23** (**23**Y, **23**M, **23**C, **23**K) by the supply roller **27** (**27**Y, **27**M, **27**C, **27**K). The developing roller **23** (**23**Y, **23**M, **23**C, **23**K) contacts the photosensitive drum **22** (**22**Y, **22**M, **22**C, **22**K). A developing bias (developing voltage) is applied to the developing roller **23** (**23**Y, **23**M, **23**C, **23**K), the electrostatic latent image is developed with toner, and a toner image is formed on the photosensitive drum **22** (**22**Y, **22**M, **22**C, **22**K).

The apparatus main body **100** includes an intermediate transfer belt **25** as an intermediate transfer member. Within the intermediate transfer belt **25**, a primary transfer roller **24** corresponding to each photosensitive drum **22** (**22**Y,**22**M, **22**C, **22**K) is arranged.

A transfer voltage is applied to the primary transfer roller **24**, whereby the toner image formed on the photosensitive drum **22** (**22**Y, **22**M, **22**C, **22**K) is transferred onto the intermediate transfer belt **25**. Then, a toner image made of overlapped four colors is conveyed to the secondary transfer unit. Then, the toner image is transferred from the intermediate transfer belt **25** onto the recording material by the secondary transfer roller **26**.

The recording material onto which the toner image is transferred is conveyed to a fixing roller **31** in a fixing device while holding the toner images. Then, heat and pressure are applied to the recording material. In this way, the toner image is fixed to the recording material. The recording material subjected to the fixing process is discharged to a sheet discharge tray **34** through a sheet discharge roller **32**.

In a case where two-sided printing is performed on the recording material, the recording material subjected to the fixing process is conveyed to a reverse roller **33**. Further, the recording material is switched back by the reverse roller **33** and conveyed to conveyance roller pairs **41** and **42**. Then, the recording material is conveyed to the conveyance roller pair **15** again by the conveyance roller pairs **41** and **42**. An image is formed on the back surface of the recording material by a procedure similar to that on the front surface of the recording material, and the recording material is discharged to the sheet discharge tray **34**.

The apparatus main body **100** includes a control unit **101** that controls the image forming operation on the recording material as described above, and a main driving unit **50**.

<Driving Configuration of Development Movement Mechanism>

The apparatus main body **100** includes a development movement mechanism (movement mechanism or development contact/separation mechanism) for moving the developing unit **71** relative to the photosensitive unit **70**. The development movement mechanism moves the developing unit **71** (**71**Y, **71**M, **71**C, **71**K) so that the photosensitive drum **22** and the developing roller **23** enter a contact state when an image is formed, and the photosensitive drum **22** and the developing roller **23** enter a separation state except when an image is formed.

The apparatus main body **100** includes a main driving unit **50**. With reference to FIGS. **2**, **3**A, **3**B, and **3**C, the configuration of the main driving unit **50** is described.

FIG. **2** is a perspective view of the main driving unit **50** according to the present exemplary embodiment.

FIGS. **3**A to **3**C are perspective views illustrating the inside of the main driving unit **50** according to the present exemplary embodiment. FIG. **3**A is a perspective view illustrating the main driving unit **50** in a separation mode. FIG. **3**B is a perspective view illustrating the main driving unit **50** in a color mode. FIG. **3**C is a perspective view illustrating the main driving unit **50** in a mono mode (monochrome mode).

The main driving unit **50** illustrated in FIG. **2** includes drum driving units **58**Y, **58**M, **58**C, and **58**K that drive the photosensitive drums **22**Y, **22**M, **22**C, and **22**K, respectively. The main driving unit **50** includes development driving units **59**Y, **59**M, **59**C, and **59**K that drive the developing rollers **23**Y, **23**M, **23**C, and **23**K, respectively. Further, the main driving unit **50** includes a gear train that drives the development movement mechanism for moving the developing unit **71**.

As illustrated in FIGS. **3**A to **3**C, the main driving unit **50** includes a contact/separation motor **51** serving as a driving source. A pinion gear is attached to an output shaft of the contact/separation motor **51** and meshes with a stepped gear **52**.

As illustrated in FIGS. **2**, **3**A, **3**B, and **3**C, the main driving unit **50** includes a worm shaft **53** extending in a direction intersecting (in the present exemplary embodiment, orthogonal to) the rotational axis direction of the stepped gear **52**. In other words, the rotational axis direction of the worm shaft **53** intersects the rotational axis direction of the stepped gear **52**. The rotational axis direction of the worm shaft **53** intersects the rotational axis directions of the drum driving units **58**Y, **58**M, **58**C, and **58**K and the development driving units **59**Y, **59**M, **59**C, and **59**K.

The worm shaft **53** is provided with a worm wheel gear **54** and a worm gear **55** (**55**Y, **55**M, **55**C, **55**K). The main driving unit **50** includes a cam gear **56** (**56**Y, **56**M, **56**C, **56**K) and a cam portion **57** (**57**Y, **57**M, **57**C, **57**K) that correspond to each process cartridge P.

The worm wheel gear **54** meshes with the stepped gear **52**. The worm gear **55** (**55**Y, **55**M, **55**C, **55**K) meshes with the cam gear **56** (**56**Y, **56**M, **56**C, **56**K). The cam gear **56** (**56**Y, **56**M, **56**C, **56**K) and the cam portion **57** (**57**Y, **57**M, **57**C, **57**K) are configured to integrally rotate.

The worm wheel gear **54** and the worm gear **55** (**55**Y, **55**M, **55**C, **55**K) are fixed to the worm shaft **53** with metal pins (not illustrated) and restricted from rotating relative to the worm shaft **53**. Thus, if the contact/separation motor **51** rotates, the worm wheel gear **54** and the worm shaft **53** rotate by the stepped gear **52**, and the worm gear **55** (**55**Y, **55**M, **55**C, **55**K) rotates. If the worm gear **55** (**55**Y, **55**M, **55**C, **55**K) rotates, the cam gear **56** (**56**Y, **56**M, **56**C, **56**K) and the cam portion **57** (**57**Y, **57**M, **57**C, **57**K) rotate.

The contact/separation motor **51**, the stepped gear **52**, the worm shaft **53**, the worm wheel gear **54**, the worm gear **55** (**55**Y to **55**K), the cam gear **56** (**56**Y to **56**K), and the cam portion **57** (**57**Y to **57**K) can be said to be a part of the development movement mechanism for moving the developing unit **71**. A movement unit **90** can also be said to be a part of the development movement mechanism.

The cam gear **56** (**56**Y to **56**K) and the cam portion **57** (**57**Y to **57**K) are configured to integrally rotate by the worm shaft **53** and the worm gear **55** (**55**Y to **55**K). In other words, in the main driving unit **50** according to the present exemplary embodiment, the cam portions **57** (**57**Y, **57**M, **57**C, **57**K) corresponding to the respective process cartridges P are configured to be integrally driven by driving a single contact/separation motor **51**.

The phases of the cam portions **57** (**57**Y, **57**M, **57**C, **57**K) corresponding to the respective process cartridges P are shifted from each other. With this configuration, if the

contact/separation motor **51** rotates in one direction, the process cartridges P are configured to perform a contact operation and a separation operation in a sequential order.

The control unit **101** controls the main driving unit **50**. More specifically, the control unit **101** can control the contact/separation motor **51** to change the position (rotational phase) of the cam portion **57** (**57**Y, **57**M, **57**C, **57**K) to a separation mode (FIG. **3**A), a color mode (FIG. **3**B), and a mono mode (FIG. **3**C).

The state where the position of the cam portion **57** (**57**Y, **57**M, **57**C, **57**K) is in the separation mode can also be referred to as "the separation mode of the image forming apparatus **1** or the main driving unit **50**". The state where the position of the cam portion **57** (**57**Y, **57**M, **57**C, **57**K) is in the color mode can also be referred to as "the color mode of the image forming apparatus **1** or the main driving unit **50**". The state where the position of the cam portion **57** (**57**Y, **57**M, **57**C, **57**K) is in the mono mode can also be referred to as "the mono mode of the image forming apparatus **1** or the main driving unit **50**".

The control unit **101** is configured to execute an image forming operation (first image forming operation) in the state where the main driving unit **50** of the image forming apparatus **1** is in the mono mode. The control unit **101** is configured to execute an image forming operation (second image forming operation) in the state where the main driving unit **50** of the image forming apparatus **1** is in the color mode.

<Details of Development Movement Mechanism>

Next, with reference to FIGS. **4**A to **4**E, the details of a movement unit **90** as a part of the development movement mechanism are described.

FIGS. **4**A to **4**E are perspective views of the movement unit **90**. FIG. **4**A is an overall perspective view of the movement unit **90**. FIG. **4**B is a partial enlarged view of one end side of the movement unit **90** (front side of the apparatus main body **100**). FIG. **4**C is a partial enlarged view of the other end side of the movement unit **90** (back side of the apparatus main body **100**). FIG. **4**D is a partial enlarged view of the one end side of the movement unit **90** in a state where a slider **61** is omitted. FIG. **4**E is a partial enlarged view of the other end side of the movement unit **90** (back side of the apparatus main body **100**) in a state where the slider **61** is omitted.

As illustrated in FIGS. **4**A to **4**E, the movement unit **90** includes a lever **60** that comes into contact with the cam portion **57**, a slider **61** connected to the lever **60**, movement members **64** connected to the slider **61**, and biasing members **65**. The lever **60** has a function of a cam follower that comes into contact with the cam portion **57**. One of the movement members **64** is configured to come into contact with the developing unit **71** and has a function of a pressing member (movement member) that moves the developing unit **71** by pressing the developing unit **71**. The slider **61** and the lever **60** have a function of a coupling portion (intermediate portion) that couples the movement member **64** and the cam portion **57**. The apparatus main body **100** includes four movement units **90** to correspond to the respective process cartridges P (PY, PM, PC, PK). The configurations of the movement units **90** are the same.

The lever **60** is supported by a frame **99** of the apparatus main body **100** so that the lever **60** can rotate about a lever center **60***a*. More specifically, the lever **60** includes a columnar portion at a position corresponding to the lever center **60***a*, and the columnar portion is inserted into a hole provided in the frame **99**. In this way, the lever **60** is held pivotably about the lever center **60***a* (FIGS. **4**C and **4**E). As illustrated in FIG. **4**C, the lever **60** includes a boss portion **60***b* and is fitted to a long round hole of the slider **61**.

If the cam portion **57** rotates so as to increase the cam radius at a portion where the cam portion **57** and the lever **60** opposes each other, the cam portion **57** comes into contact with the lever **60**. Then, the lever **60** rotates (swings) about the lever center **60***a* in the direction of an arrow A**2** (separation direction).

In an opposite manner, if the cam portion **57** rotates so as to decrease the cam radius at the portion where the cam portion **57** and the lever **60** oppose each other, the lever **60** swings in the direction of an arrow A**1** (contact direction). If the cam portion **57** continues to rotate, the cam portion **57** separates from the lever **60**.

On the other hand, the slider **61** is held by slider guides **62** and **63** fixed to the frame **99** so that the slider **61** can linearly move in the front surface direction (B**1** direction) and the back surface direction (B**2** direction) of the apparatus main body **100** (FIGS. **4**D and **4**E). In the present exemplary embodiment, the front surface direction (B**1** direction) and the back surface direction (B**2** direction) of the apparatus main body **100** are parallel to the direction of the rotational axis of the photosensitive drum **22**, the direction of the rotational axis of the developing roller **23**, the direction of the pinion gear of the contact/separation motor **51**, and the direction of the rotational axis of the stepped gear **52**. The direction in which the process cartridge P is attached to the apparatus main body **100** is the same direction as the B**2** direction. The direction in which the process cartridge P is taken out of the apparatus main body **100** is the same direction as the B**1** direction.

If the lever **60** rotates in the A**1** direction, the slider **61** moves in the B**1** direction (contact direction). If the lever **60** rotates in the A**2** direction, the slider **61** moves in the B**2** direction (separation direction).

The movement members **64** and the biasing members (compression springs) **65** are provided at two locations in the moving direction of the slider **61** (FIGS. **4**D and **4**E). Each movement member **64** is supported by the frame **99** of the apparatus main body **100** so that the movement member **64** can rotate about a rotation center **64***c*. More specifically, the movement member **64** includes a columnar portion at a position corresponding to the rotation center **64***c*, and the columnar portion is inserted into a hole provided in the frame **99**. In this way, the movement member **64** is held pivotably about the rotation center **64***c*.

On the other hand, a spring reception portion **66** is provided in the frame **99**. Then, the biasing member **65** is attached between the movement member **64** and the spring reception portion **66**.

A bending portion **61***a* is provided in the slider **61** and can come into contact with a rib **64***d* of the movement member **64**. If the slider **61** moves by a certain amount or more in the B**2** direction (separation direction), the bending portion **61***a* and the rib **64***d* come into contact with each other, the movement member **64** pivots, and the biasing member **65** is compressed. In an opposite manner, if the slider **61** moves by a certain amount or more in the B**1** direction (contact direction), the bending portion **61***a* and the rib **64***d* separate from each other.

<Relationship Between Development Movement Mechanism and Process Cartridge>

Next, with reference to FIGS. **5**A, **5**B, and **5**C, a relationship between the development movement mechanism and each process cartridge P is described.

FIGS. **5**A to **5**C are side views of each process cartridge P according to the present exemplary embodiment. FIG. **5**A

is a side view of the process cartridge P in a case where the developing unit **71** is in a contact state. FIG. **5**B is a side view of the process cartridge P in a case where the developing unit **71** is in a separation state. FIG. **5**C is a side view of the process cartridge P in a case where the developing unit **71** is in an intermediate state (small separation state). FIGS. **5**A, **5**B, and **5**C are views of the process cartridge P viewed along the rotational axis of the developing roller **23**. In the present exemplary embodiment, the rotational axis of the developing roller **23** is parallel to the rotational axis of the photosensitive drum **22** and the rotational axis of the developing unit **71**.

The developing unit **71** is configured to pivot about a pin **71***a* as a swinging center while rotatably supporting the developing roller **23**. In the present exemplary embodiment, the developing unit **71** is joined to the photosensitive unit **70** so that the developing unit **71** can rotate about the pin **71***a*. The present disclosure, however, can also be applied to a configuration in which the developing unit **71** and the photosensitive unit **70** are independently supported by the apparatus main body **100**.

The developing unit **71** includes a pressing target portion **71***b* to be pressed by a pressing portion **64***a* of the movement member **64**. The pressing target portion **71***b* has a function of a force reception portion that receives a force from the pressing portion **64***a* of the movement member **64**.

To contact the developing roller **23** to the photosensitive drum **22**, the lever **60** rotates in the A**1** direction, and the slider **61** moves in the B direction. Then, the movement member **64** rotates about the rotation center **64***c*, and the pressing portion **64***a* comes into contact with the pressing target portion **71***b*. Then, the developing unit **71** rotates in the clockwise direction in FIG. **5**A and biases the developing roller **23** toward the photosensitive drum **22** (FIG. **5**A). In the present exemplary embodiment, the biasing member **65** biases the movement member **64** toward the developing unit **71**. In other words, the movement member **64** biases the developing unit **71** by the biasing force of the biasing member **65**. The position of the developing unit **71** when the developing roller **23** contacts the photosensitive drum **22** is referred to as a "contact position". The state where the developing unit **71** is located at the contact position is referred to as a "contact state of the developing unit **71**".

When the developing roller **23** is separated from the photosensitive drum **22**, the lever **60** rotates in the A**2** direction, and the slider **61** moves in the B**2** direction. Then, the movement member **64** rotates about the rotation center **64***c*, and the pressing portion **64***a* retracts in the right direction in FIG. **5**B. If the pressing portion **64***a* retracts, the developing unit **71** rotates under its own weight in the counterclockwise direction, and the photosensitive drum **22** and the developing roller **23** separate from each other.

On the other hand, the apparatus main body **100** includes a weight sensor **73** that comes into contact with the developing unit **71** and measures the weight of the developing unit **71**. The weight of the developing unit **71** is detected, whereby the amount of toner stored in the developing unit **71** is detected.

In the present exemplary embodiment, to prevent influence on the measurement of the weight sensor **73**, when the developing unit **71** comes into contact with the weight sensor **73**, the pressing portion **64***a* of the movement member **64** is located at a position separate from the pressing target portion **71***b* (separation state of the developing unit **71**).

The movement member **64** can also bring the developing unit **71** into a small separation state (FIG. **5**C) so that the developing roller **23** separates from the photosensitive drum **22**, and the developing unit **71** separates from the weight sensor **73**.

On the other hand, the movement member **64** includes a separation guarantee portion **64***b* arranged with a space from the pressing target portion **71***b*. The separation guarantee portion **64***b* is configured to come into contact with the pressing target portion **71***b* when shock is given to the apparatus main body **100** due to a fall while the image forming apparatus **1** is carried in a state where the process cartridge P is attached to the apparatus main body **100**. This prevents the developing roller **23** from colliding with the photosensitive drum **22**.

The space between the photosensitive drum **22** and the developing roller **23** when the developing unit **71** is located at a small separation position is smaller than the space between the photosensitive drum **22** and the developing roller **23** when the developing unit **71** is located at the separation position. In other words, the distance between the photosensitive drum **22** and the developing roller **23** when the developing unit **71** is located at the small separation position is shorter than the distance between the photosensitive drum **22** and the developing roller **23** when the developing unit **71** is located at the separation position. When the developing unit **71** is located at the small separation position, the position of the developing unit **71** is determined by the pressing target portion **71***b* coming into contact with the pressing portion **64***a*, and the developing unit **71** is not in contact with the weight sensor **73**.

When the cam portion **57** is in a contact phase (a phase where the developing unit **71** is located at the contact position), the movement member **64** presses the developing unit **71** by the elastic force of the biasing member **65**, and the photosensitive drum **22** and the developing roller **23** are located in the contact state.

In the present exemplary embodiment, when the cam portion **57** is in a separation phase (a phase where the developing unit **71** is located at the separation position) or a small separation phase (a phase where the developing unit **71** is located at the small separation position), the cam portion **57** presses the movement member **64** via the lever **60** and the slider **61**. At this time, the cam portion **57** locates the movement member **64** at a separation position of the movement member **64** or a small separation position of the movement member **64** against the elastic force of the biasing member **65**. The developing unit **71** moves under its own weight in the direction in which the developing roller **23** separates from the photosensitive drum **22**. Then, the developing unit **71** is located at the separation position or the small separation position.

<Relationship Between the Shape of the Cam Portion and the Lever>

In the present exemplary embodiment, the cam portions **57**Y, **57**M, and **57**K corresponding to the process cartridges PY, PM, and PK have a same shape. On the other hand, the cam portion **57**C corresponding to the process cartridge C adjacent to the process cartridge PK has a different shape from those of the cam portions **57**Y, **57**M, and **57**K. Based on the cam portion **57**C, the relationship between the shape of the cam portion **57** and the lever **60** is described.

FIGS. **6**A to **6**C are diagrams each illustrating a relationship between the cam portion **57** (**57**C) and the lever **60**. FIG. **6**A is a diagram illustrating a relationship between the cam portion **57** (**57**C) and the lever **60** in the separation state. FIG. **6**B is a diagram illustrating a relationship between the cam portion **57** (**57**C) and the lever **60** in the contact state.

FIG. **6**C is a diagram illustrating a relationship between the cam portion **57** (**57**C) and the lever **60** in the small separation state.

In the present exemplary embodiment, the cam portion **57**C includes a first cam surface (separation surface) **57***a* and a second cam surface (small separation surface) **57***b*. The cam portions **57**Y, **57**M, and **57**K do not include the second cam surface **57***b*, and the first cam surface **57***a* extends as indicated by a dotted line in FIG. **6**A. The shapes of the cam portions **57**Y, **57**M, **57**C, and **57**K are the same except for the presence or absence of the second cam surface **57***b*. The first cam surface **57***a* is a surface having the greatest distance (radius) from a rotation center **57***d* in a cam surface that comes into contact with the lever **60**.

The cam portion **57** and the cam gear **56** are configured to rotate about the rotation center **57***d*. In the present exemplary embodiment, the first cam surface **57***a* has an arc shape having an approximately constant distance (radius) from the rotation center **57***d*. The second cam surface **57***b* has an arc shape having an approximately constant distance (radius) from the rotation center **57***d*. The first cam surface **57***a* and the second cam surface **57***b* are arranged in approximately concentric circles. In other words, the center of the arc shape of the first cam surface **57***a* coincides with the rotation center **57***d* of the cam portion **57**. The center of the arc shape of the second cam surface **57***b* coincides with the rotation center **57***d* of the cam portion **57**.

The first cam surface **57***a* and the second cam surface **57***b* are not limited to the arc shape, and may have curved surfaces or flat surfaces. In order for the second cam surface **57***b* to stably receive the lever **60**, it is desirable that an amount of change in the distance from the rotation center **57***d* with respect to an amount of rotation of the cam portion **57** is smaller in the second cam surface **57***b* than in portions ahead of and behind the second cam surface **57***b* in the rotational direction of the cam portion **57**.

When the developing unit **71** is brought into the separation state, the cam portion **57** is located so that the lever **60** comes into contact with the first cam surface (separation surface) **57***a*. At this time, the lever **60** rotates in the A2 direction illustrated in FIG. **4**C, and the developing unit **71** enters the separation state (state where the developing unit **71** is located at the separation position).

Next, when the developing unit **71** is brought into the contact state, the cam portion **57** is located so that the lever **60** does not come into contact with the cam portion **57**. At this time, the lever **60** rotates in the A1 direction illustrated in FIG. **4**C, and the developing unit **71** enters the contact state.

In the present exemplary embodiment, the developing unit **71** (**71**C) of the process cartridge PC can be located at the small separation position. When the developing unit **71** (**71**C) is brought into the small separation state (state where the developing unit **71** (**71**C) is located at the small separation position), the cam portion **57** (**57**C) is located so that the lever **60** comes into contact with the second cam surface **57***b*. At this time, the lever **60** rotates in the A2 direction, but the amount of rotation of the lever **60** in the A2 direction is smaller than that when the developing unit **71** is brought into the separation state.

To stably form an image on the recording material, it is desirable to contact the photosensitive drum **22** and the developing roller **23** in the entire area in the longitudinal direction (same direction as the rotational axis direction of the photosensitive drum **22** and the rotational axis direction of the developing roller **23**). Accordingly, it is necessary to make the biasing force of the biasing member **65** large. Further, it is desirable to arrange the movement members **64** and the biasing members **65** at two locations in the longitudinal direction.

On the other hand, if the biasing force of the biasing member **65** or the numbers of movement members **64** and biasing members **65** increase, and when the developing unit **71** is brought into the separation state or the small separation state, a force applied to the lever **60** and the cam portion **57** becomes large. If the lever **60** is in the state of contacting a sloping surface of the cam portion **57**, the cam portion **57** or the cam gear **56** may rotate. Thus, in the present exemplary embodiment, each of the first cam surface **57***a* and the second cam surface **57***b* have an approximately constant distance (radius) from the rotation center **57***d*, and the first cam surface **57***a* and the second cam surface **57***b* are arranged in approximately concentric circles. This can prevent the generation of a force in the rotational direction in the cam gear **56** or the cam portion **57** and maintain the phase of the cam gear **56** or the cam portion **57**.

The movement unit **90** that moves the worm gear **55**Y, the cam gear **56**Y, the cam portion **57**Y, and the developing unit **71**Y can be said to be a part of the movement mechanism (fourth movement mechanism or fourth position regulation mechanism) for moving the developing unit **71**Y. This movement mechanism regulates the position of the developing unit **71**Y and enables the developing unit **71**Y to move to the contact position and the separation position.

Similarly, the movement unit **90** that moves the worm gear **55**M, the cam gear **56**M, the cam portion **57**M, and the developing unit **71**M can be said to be a part of the movement mechanism (third movement mechanism or third position regulation mechanism) for moving the developing unit **71**M. This movement mechanism regulates the position of the developing unit **71**M and enables the developing unit **71**M to move to the contact position and the separation position.

Similarly, the movement unit **90** that moves the worm gear **55**C, the cam gear **56**C, the cam portion **57**C, and the developing unit **71**C can be said to be a part of the movement mechanism (second movement mechanism or second position regulation mechanism) for moving the developing unit **71**C. This movement mechanism regulates the position of the developing unit **71**C and enables the developing unit **71**C to move to the contact position, the separation position, and the intermediate position (small separation position).

Similarly, the movement unit **90** that moves the worm gear **55**K, the cam gear **56**K, the cam portion **57**K, and the developing unit **71**K can be said to be a part of the movement mechanism (first movement mechanism or first position regulation mechanism) for moving the developing unit **71**K. This movement mechanism regulates the position of the developing unit **71**K and enables the developing unit **71**K to move to the contact position and the separation position.

<Operation of Image Forming Apparatus>

If the state where the photosensitive drum **22** and the developing roller **23** contact each other continues for an extended time, the developing roller **23** can deform. If the photosensitive drum **22** and the developing roller **23** are rotated in a state where the photosensitive drum **22** and the developing roller **23** contact each other, the photosensitive drum **22** and the developing roller **23** rub against each other, and the surface of the developing roller **23** or the photosensitive drum **22** minutely wears away. If the state where the developing roller **23** rotates in a state of contacting the photosensitive drum **22** continues for an extended time, the developing roller **23** or the photosensitive drum **22** can

deteriorate. This may result in deteriorating the quality of an image to be formed on the recording material.

To address this problem, in the present exemplary embodiment, when an image forming operation is not performed, the developing roller **23** is separated from the photosensitive drum **22**, thereby preventing the deterioration of the developing roller **23** or the photosensitive drum **22**.

Taking such a point into consideration, with reference to FIG. **7**, the operation of the image forming apparatus **1** according to the present exemplary embodiment is described. FIG. **7** is a cam diagram illustrating the operation of the image forming apparatus **1** according to the present exemplary embodiment.

The image forming apparatus **1** can execute image forming operations on the recording material in the color mode and the mono mode. The image forming apparatus **1** can also bring all the process cartridges PY, PM, PC, and PK into a state where the developing rollers **23**Y, **23**M, **23**C, and **23**K are separate from the photosensitive drums **22**Y, **22**M, **22**C, and **22**K, respectively (separation mode).

In the color mode, the image forming operation is performed in a state where the developing rollers **23**Y, **23**M, **23**C, and **23**K contact the photosensitive drums **22**Y, **22**M, **22**C, and **22**K, respectively.

In the mono mode, the image forming operation is performed in a state where the developing roller **23**K contacts the photosensitive drum **22**K, and the developing rollers **23**Y, **23**M, and **23**C are separate from the photosensitive drums **22**Y, **22**M, and **22**C, respectively. In other words, the image forming apparatus **1** can perform the image forming operation using a part of the image forming units (process cartridge PK). When the image forming operation is performed in the mono mode, the contact/separation motor **51** is stopped, and the above state is maintained.

The separation mode, the color mode, and the mono mode are switched by the control unit **101** controlling the contact/separation motor **51** of the main driving unit **50** to move the movement member **64**. More specifically, the control unit **101** can execute the image forming operation (first image forming operation) in a state where the developing roller **23**K contacts the photosensitive drum **22**K, and the developing rollers **23**Y, **23**M, and **23**C are separate from the photosensitive drums **22**Y, **22**M, and **22**C, respectively (mono mode). The control unit **101** can execute the image forming operation (second image forming operation) in a state where the developing rollers **23**Y, **23**M, **23**C, and **23**K contact the photosensitive drums **22**Y, **22**M, **22**C, and **22**K, respectively (color mode).

If the contact/separation motor **51** rotates in a first direction, the main driving unit **50** of the image forming apparatus **1** changes so as to follow the cam diagram in FIG. **7** from left to right. If the contact/separation motor **51** rotates in a second direction that is opposite to the first direction, the main driving unit **50** of the image forming apparatus **1** changes so as to follow the cam diagram in FIG. **7** from right to left.

More specifically, as illustrated in FIG. **7**, if the contact/separation motor **51** rotates in the first direction in a state where the image forming apparatus **1** is in the separation mode, the image forming apparatus **1** changes to the color mode. If the contact/separation motor **51** further rotates in the first direction, the image forming apparatus **1** changes to the mono mode. If the contact/separation motor **51** further rotates in the first direction, the image forming apparatus **1** changes to the separation mode. In the state where the image forming apparatus **1** is in the separation mode, the contact/separation motor **51** can rotate in the second direction opposite to the first direction and change the image forming apparatus **1** to the mono mode.

Before the image forming operation is executed, the image forming apparatus **1** waits in the separation state, and each of the developing unit **71**Y, **71**M, **71**C, and **71**K is located at the separation position. At this time, the contact/separation motor **51** is stopped, and each of the cam portions **57**Y, **57**M, **57**C, and **57**K contacts the corresponding lever **60** on the first cam surface **57***a* (see FIG. **6**A).

If the image forming operation is started, the control unit **101** starts driving the contact/separation motor **51**. In synchronization with the timing of the image formation of the process cartridges PY, PM, PC, and PK, the developing roller **23** contacts the photosensitive drum **22** in the order of the process cartridges PY, PM, PC, and PK. If the developing roller **23** contacts the photosensitive drum **22** in all of the process cartridges PY, PM, PC, and PK, the image forming apparatus **1** changes to the color mode, and the contact/separation motor **51** is stopped. At this time, each of the cam portions **57**Y, **57**M, **57**C, and **57**K is separate from the corresponding lever **60**. Then, the image forming apparatus **1** can perform the image forming operation in this state.

The image forming operation of the process cartridges PY, PM, PC, and PK ends in the order of the process cartridges PY, PM, PC, and PK. Thus, the contact/separation motor **51** is driven, and in synchronization with the timing when the image forming operation of the process cartridges PY, PM, PC, and PK ends, the developing roller **23** separates from the photosensitive drum **22** in the order of the process cartridges PY, PM, PC, and PK. The rotational direction of the contact/separation motor **51** is the same as the rotational direction when the image forming apparatus **1** is switched from the separation mode to the color mode. More specifically, after the image forming operation in the color mode ends, the image forming apparatus **1** returns from the color mode through the mono mode to the separation mode.

At this time, after the image forming operation in the color mode is performed, and if the image forming operation is not to be performed in the mono mode, the contact/separation motor **51** does not stop. After the image forming operation in the color mode is performed, and if the image forming operation is to be performed in the mono mode, the contact/separation motor **51** temporarily stops in the mono mode, and the image forming operation is performed. Then, the image forming apparatus **1** returns to the separation mode.

At this time, as illustrated in FIG. **7**, in the present exemplary embodiment, the developing unit **71**C moves through the small separation position (intermediate position) to the separation position. Then, the movement mechanism for moving the developing unit **71**K is configured to start moving the developing unit **71**K from the contact position to the separation position in a state where the developing unit **71**C is located between the contact position and the separation position.

As illustrated in FIG. **7**, in the mono mode according to the present exemplary embodiment, the developing unit **71**Y is located at the separation position, and the developing unit **71**M is located at the separation position. Then, the developing unit **71**C is located at the small separation position (intermediate position) between the contact position and the separation position. At this time, in each of the cam portions **57**Y and **57**M, the first cam surface **57***a* contacts the lever **60**. In the cam portion **57**C, the second cam surface **57***b* contacts the lever **60**. The control unit **101** is configured to stop the contact/separation motor **51** in this state and execute the image forming operation.

In the mono mode, the space between the developing roller **23**C and the photosensitive drum **22**C is smaller when the developing unit **71**C is located at the small separation position than when the developing unit **71**C is located at the separation position. The amount of separation of the developing unit **71**C is smaller than the amount of separation of each of the developing units **71**Y and **71**M (space between the developing roller **23** and photosensitive drum **22**).

As illustrated in FIG. **7**, the moving speed of the developing unit **71**C while the second cam surface **57***b* contacts the lever **60** is slower than the moving speed of the developing unit **71**C before and after the second cam surface **57***b* contacts the lever **60**.

A description is given of the operation of the image forming apparatus **1** according to the present exemplary embodiment and the operation of an image forming apparatus according to a comparative example. FIG. **11** is a cam diagram illustrating the operation of the image forming apparatus according to the comparative example.

As illustrated in FIG. **11**, in the image forming apparatus according to the comparative example, in a state where each of the developing units **71**Y, **71**M, and **71**C is located at the separation position, the developing unit **71**K starts moving from the contact position to the separation position. In the mono mode according to the comparative example, each of the developing units **71**Y, **71**M, and **71**C is located at the separation position.

To perform the image forming operation in the mono mode, it is necessary to maintain the developing unit **71**K at the contact position in the state where the developing units **71**Y, **71**M, and **71**C are separate. If the developing unit **71**K is separated immediately after the developing units **71**Y, **71**M, and **71**C separate, it is difficult to perform the image forming operation in the mono mode. Thus, the timing of the separation of the developing unit **71**K is delayed, and only the process cartridge PK is brought into the contact state between the color mode and the separation mode. Thus, the time during which the photosensitive drum **23** and the developing roller **22** contact each other (contact time) is longer in the process cartridge PK than in the process cartridges PY, PM, and PC.

In the mono mode of the present exemplary embodiment, each of the process cartridges PY and PM is in the separation state, the process cartridge PC is in the small separation state, and the process cartridge PK is in the contact state. In other words, the image forming apparatus **1** according to the present exemplary embodiment is configured to start moving the developing unit **71**K to the separation position before the developing unit **71**C reaches the separation position. On the other hand, in the mono mode of the comparative example illustrated in FIG. **11**, each of the process cartridges PY, PM, and PC is in the separation state, and the process cartridge PK is in the contact state. In other words, the image forming apparatus according to the comparative example is configured to start moving the developing unit **71**K to the separation position after the developing unit **71**C reaches the separation position.

More specifically, in the present exemplary embodiment, the image forming apparatus **1** is configured so as to perform the image forming operation in the mono mode, whereby the timing when the developing unit **71**K starts moving to the contact position can be put ahead.

In the configuration of the present exemplary embodiment, the positions for the color mode and the mono mode can be brought closer to each other than in the comparative example. More specifically, in the process in which the image forming apparatus **1** changes to the separation mode, the color mode, the mono mode, and the separation mode, the point where the image forming apparatus **1** changes to the color mode and the point where the image forming apparatus **1** changes to the mono mode can be brought close to each other. Thus, the time from when the image forming operation in the color mode ends to when the developing unit **71**K starts moving to the separation position can be made shorter than in the comparative example. As a result, in the developing unit **71**K, the time during which the state where the developing roller **23** contacts the photosensitive drum **22** is maintained can be made shorter than in the comparative example. In this way, in the developing unit **71**K, it is possible to reduce the wearing away of the photosensitive drum **22** and the developing roller **23** and to prevent the deterioration of the photosensitive drum **22** and the developing roller **23**.

Further, in the present exemplary embodiment, in the mono mode, the cam portion **57**C is in the state where the lever **60** contacts the second cam surface **57***b*. Thus, even in the state before the developing unit **71**C reaches the separation position, it is possible to prevent the cam portion **57**C from rotating by receiving a force from the lever **60**. It is also possible to determine the position of the developing unit **71**C with high accuracy. Thus, it is possible to stably execute the image forming operation in the mono mode.

In the present exemplary embodiment, the main driving unit **50** includes a gear train that transmits drive to the development driving units **59**Y, **59**M, **59**C, and **59**K that drive the developing rollers **23**Y, **23**M, **23**C, and **23**K, respectively. A clutch (not illustrated) is arranged in the gear train. If the developing roller **23** is in the separation state, drive to the developing roller **23** is disconnected. Immediately before the developing roller **23** contacts the photosensitive drum **22**, drive to the developing roller **23** is transmitted. Immediately after the developing roller **23** separates from the photosensitive drum **22**, drive to the developing roller **23** is disconnected.

In the present exemplary embodiment, the clutch is provided in each of the development driving units **59**Y, **59**M, **59**C, and **59**K. Each clutch is coupled to the cam gear **56** (**56**Y, **56**M, **56**C, **56**K) through a gear (not illustrated). At this time, the clutch is attached so that the timings of a development operation and a separation operation of the developing roller **23** are linked to the timings of the transmission and the disconnection of drive to the developing roller **23**.

With this configuration, drive to the developing roller **23** is disconnected except when an image is formed. Thus, it is possible to reduce the total number of rotations of the developing roller **23**. It is possible to prevent the wearing away of the developing roller **23** and the supply roller **27** that contacts the developing roller **23** and the deterioration of toner due to the friction between the developing roller **23** and the supply roller **27**.

As described above, the image forming apparatus **1** can execute an image forming operation using the process cartridge PK that is a part of the image forming units, and also shorten the time during which the state where the developing roller **23**K and the photosensitive drum **22**K contact each other is maintained.

A second exemplary embodiment is described. Portions similar to those in the first exemplary embodiment are not described. The second exemplary embodiment is different from the first exemplary embodiment in the timing when the developing unit **71**K starts moving to the separation position. The second exemplary embodiment is also different

from the first exemplary embodiment in the operation of the developing unit **71**M through the color mode to the separation mode.

With reference to FIG. **8**, the operation of the image forming apparatus **1** according to the second exemplary embodiment is described. With reference to FIG. **9**, a configuration of a cam portion **157** according to the second exemplary embodiment is described.

FIG. **8** is a cam diagram illustrating the operation of the image forming apparatus **1** according to the second exemplary embodiment. FIG. **9** is a diagram illustrating a relationship between the cam portion **157** and the lever **60** according to the second exemplary embodiment.

Similar to the first exemplary embodiment, after the image forming operation in the color mode ends, the image forming apparatus **1** returns from the color mode through the mono mode to the separation mode.

As illustrated in FIG. **8**, each of the developing units **71**M and **71**C moves through the intermediate position to the separation position. In the present exemplary embodiment, the developing unit **71**K is configured to start moving from the contact position to the separation position in a state where each of the developing units **71**M and **71**C is between the contact position and the separation position.

As illustrated in FIG. **8**, in the mono mode according to the present exemplary embodiment, the developing unit **71**Y is located at the separation position, and each of the developing units **71**M and **71**C is located at the small separation position. In other words, each of the developing units **71**M and **71**C is located at the intermediate position (small separation position) between the contact position and the separation position. The control unit **101** is configured to execute the image forming operation in this state.

The image forming apparatus **1** according to the present exemplary embodiment is configured to start moving the developing unit **71**K to the separation position before each of the developing units **71**M and **71**C reaches the separation position.

As a result, in the configuration of the present exemplary embodiment, the positions for the color mode and the mono mode can be brought even closer to each other. The time from when the image forming operation in the color mode ends to when the developing unit **71**K starts moving to the separation position can be made even shorter. As a result, in the developing unit **71**K, the time during which the state where the developing roller **23** contacts the photosensitive drum **22** is maintained can be made shorter than in the comparative example. In this way, it is possible to reduce the wearing away of the photosensitive drum **22** and the developing roller **23** and to prevent the deterioration of the photosensitive drum **22** and the developing roller **23**.

The second cam surface **57***b* of the cam portion **57**C according to the first exemplary embodiment is a surface having an approximately constant distance (radius) from the rotation center **57***d*. The first cam surface **57***a* and the second cam surface **57***b* are arranged in approximately concentric circles.

The image forming apparatus **1** according to the second exemplary embodiment includes the cam portion **157** (**157**M) at a position corresponding to the cam portion **57**M according to the first exemplary embodiment. The shape of the cam portion **157**M is different from the shape of the cam portion **57** (**57**C).

As illustrated in FIG. **9**, similar to the cam portion **57**, the cam portion **157**M includes the first cam surface **57***a*. The cam portion **157**M includes a second cam surface **157***b* equivalent to the second cam surface **57***b* according to the first exemplary embodiment. When the image forming apparatus **1** performs the image forming operation in the mono mode, the lever **60** corresponding to the process cartridge PM contacts the second cam surface **157***b*, and the developing unit **71**M is located at the intermediate position. The lever **60** corresponding to the process cartridge PC contacts the second cam surface **57***b* of the cam portion **57**C, and the developing unit **71**C is located at the intermediate position.

The second cam surface **157***b* has a V-shaped recessed shape and sandwiches the lever **60**. More specifically, the second cam surface **157***b* includes a first reception surface extending in a direction away from the rotation center **57***d* toward the upstream side of the rotational direction of the cam portion **157**, and a second reception surface extending in a direction away from the rotation center **57***d* toward the downstream side of the rotational direction of the cam portion **157**. The lever **60** comes into contact with the first and second reception surfaces.

In this case, since the second cam surface **157***b* has a V-shape, when receiving a force from the lever **60**, the second cam surface **157***b* receives two forces in the direction in which the cam portion **157**M is rotated forward and the direction in which the cam portion **157**M is rotated backward. The second cam surface **157***b* is arranged so that these two forces cancel out each other, whereby it is possible to prevent the rotation of the cam portion **157**M.

In other words, the movement unit **90** that moves the worm gear **55**M, the cam gear **56**M, the cam portion **157**M, and the developing unit **71**M can be said to be a part of the movement mechanism (third movement mechanism or third position regulation mechanism) for moving the developing unit **71**M. This movement mechanism regulates the position of the developing unit **71**M and enables the developing unit **71**M to move to the contact position, the separation position, and the intermediate position.

Alternatively, as the cam portion **157**M, a cam portion having the same shape as that of the cam portion **57**C according to the first exemplary embodiment can also be used. Alternatively, as the cam portion **57**C according to the first exemplary embodiment, a cam portion having the same shape as that of the cam portion **157**M can also be used.

As described above, the image forming apparatus **1** can execute an image forming operation using the process cartridge PK that is a part of the image forming units, and also shorten the time during which the state where the developing roller **23**K and the photosensitive drum **22**K contact each other is maintained.

A third exemplary embodiment is described. Portions similar to those in the first and second exemplary embodiments are not described.

In the first exemplary embodiment, the developing roller **23** is caused to contact the photosensitive drum **22** by the biasing force of the biasing member **65** arranged in the development movement mechanism. In the present exemplary embodiment, the developing roller **23** is caused to contact the photosensitive drum **22** by the biasing force of a cartridge biasing member **173** arranged between the photosensitive unit **70** and the developing unit **71**.

With reference to FIGS. **10**A, **10**B, and **10**C, the relationship between the development movement mechanism and each process cartridge P according to the present exemplary embodiment is described.

FIGS. **10**A to **10**C, are side views of each process cartridge P according to the present exemplary embodiment. FIG. **10**A is a side view of the process cartridge P when the developing unit **71** is in the contact state. FIG. **10**B is a side view of the process cartridge P when the developing unit **71**

is in the separation state. FIG. **10**C is a side view of the process cartridge P when the developing unit **71** is in the intermediate state (small separation state). FIGS. **10**A, OB, and IOC are views of the process cartridge P viewed along the rotational axis of the developing roller **23**. In the present exemplary embodiment, the rotational axis of the developing roller **23** is parallel to the rotational axis of the photosensitive drum **22** and the rotational axis of the developing unit **71**.

As illustrated in FIGS. **10**A to **10**C, a cartridge biasing member **173** is arranged between the photosensitive unit **70** and the developing unit **71**. The developing unit **71** is biased in the clockwise direction by the biasing force of the cartridge biasing member **173**, and the developing roller **23** contacts the photosensitive drum **22** (FIG. **10**A).

In the present exemplary embodiment, the movement member **64** does not include the pressing portion **64***a* according to the first exemplary embodiment. When the developing roller **23** is separated from the photosensitive drum **22**, the separation guarantee portion **64***b* comes into contact with the pressing target portion **71***b*, thereby rotating the developing unit **71** in the counterclockwise direction.

When the developing unit **71** is at the separation position (FIG. **10**B) and when the developing unit **71** is at the intermediate position (FIG. **10**C), the separation guarantee portion **64***b* and the pressing target portion **71***b* come into contact with each other, whereby the photosensitive drum **22** and the developing roller **23** separate from each other.

Even in a case where such a process cartridge P is used, similar to the first or second exemplary embodiment, the time from when the image forming operation in the color mode ends to when the developing unit **71**K starts moving to the separation position can be made shorter than in the comparative example (FIG. **11**). Accordingly, in the developing unit **71**K, the time during which the developing roller **23** rotates in the state where the developing roller **23** contacts the photosensitive drum **22** can be made shorter than in the comparative example. In this way, it is possible to reduce the wearing away of the photosensitive drum **22** and the developing roller **23** and to prevent the deterioration of the photosensitive drum **22** and the developing roller **23**.

<Modified Example>

Each of the exemplary embodiments is configured to perform the image forming operations in the order of the process cartridges PY, PM, PC, and PK. However, the order of the image forming operations is not limited to this order. For example, a configuration in which the image forming operations are performed in the order of the process cartridges PK, PC, PM, and PY, may be employed. The operations of the process cartridges PK, PC, PM, and PY in this case are performed following the cam diagrams illustrated in FIGS. **7**, **8**, and II from right to left in the figures. More specifically, the image forming apparatus **1** changes to the separation mode, the mono mode, and the color mode in this order.

The states of the process cartridges PK, PC, PM, and PY in the mono mode, the color mode, and the separation mode are similar to those illustrated in each of the exemplary embodiments.

More specifically, in a case where the image forming apparatus **1** changes from the separation mode to the mono mode, and when the developing unit **71**K is located at the contact position, the developing unit **71**C or each of the developing units **71**C and **71**M is located between the separation position and the contact position.

Also in this case, the process cartridge PC or each of the process cartridges PC and PM shifts through the small separation state to the color mode, whereby the positions for the color mode and the mono mode can be brought close to each other. Thus, it is possible to shorten the time during which the state where the developing roller **23**K contacts the photosensitive drum **22**K is maintained.

According to the present disclosure, it is possible to provide an image forming apparatus capable of executing an image forming operation using a part of image forming units, and shortening the time during which the state where a developing roller and a photosensitive drum contact each other is maintained.

While the present disclosure has been described with reference to exemplary embodiments, it is to be understood that the disclosure is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of priority from Japanese Patent Application No. 2019-215828, filed Nov. 28, 2019, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

**1**. An image forming apparatus comprising:

a first image forming unit having a first drum unit including a first photosensitive drum, and a first developing unit including a first developing roller configured to contact the first photosensitive drum;

a second image forming unit having a second drum unit including a second photosensitive drum, and a second developing unit including a second developing roller configured to contact the second photosensitive drum;

a first movement mechanism configured to move the first developing unit so that the first developing unit is located at a first contact position where the first developing roller contacts the first photosensitive drum, and at a first separation position where the first developing roller is separate from the first photosensitive drum;

a second movement mechanism configured to move the second developing unit so that the second developing unit is located at a second contact position where the second developing roller contacts the second photosensitive drum, at a second separation position where the second developing roller is separate from the second photosensitive drum, and at an intermediate position between the second contact position and the second separation position; and

a control unit configured to execute a first image forming operation in a state where the first developing roller contacts the first photosensitive drum, and the second developing roller is separate from the second photosensitive drum,

wherein the first movement mechanism is configured to start moving the first developing unit from the first contact position to the first separation position in a state where the second developing unit is located between the second contact position and the second separation position.

**2**. The image forming apparatus according to claim **1**, wherein the control unit is configured to execute the first image forming operation in a state where the second developing unit is located at the intermediate position.

**3**. The image forming apparatus according to claim **2**, further comprising a third image forming unit having a third photosensitive drum, and a third developing unit including a third developing roller configured to contact the third photosensitive drum,

wherein the control unit is configured to execute the first image forming operation in a state where the third developing roller is separate from the third photosensitive drum.

**4**. The image forming apparatus according to claim **3**, further comprising a third movement mechanism configured to move the third developing unit so that the third developing unit is located at a third contact position where the third developing roller contacts the third photosensitive drum, a third separation position where the third developing roller is separate from the third photosensitive drum, and an intermediate position between the third contact position and the third separation position,

wherein the control unit is configured to execute the first image forming operation in a state where the third developing unit is located at the intermediate position between the third contact position and the third separation position.

**5**. The image forming apparatus according to claim **1**,

wherein the second movement mechanism includes a movement member configured to come into contact with the second developing unit, a cam portion configured to rotate, and a coupling portion configured to couple the movement member and the cam portion, and

wherein the cam portion includes a first cam surface and a second cam surface, and when the coupling portion comes into contact with the first cam surface, the second developing unit is located at the second separation position, and when the coupling portion comes into contact with the second cam surface, the second developing unit is located at the intermediate position between the second contact position and the second separation position.

**6**. The image forming apparatus according to claim **5**, wherein the second cam surface has an arc shape.

**7**. The image forming apparatus according to claim **6**, wherein a center of the arc shape coincides with a rotation center of the cam portion.

**8**. The image forming apparatus according to claim **5**, wherein the second movement mechanism includes a biasing member configured to bias the movement member toward the second developing unit.

**9**. The image forming apparatus according to claim **1**,

wherein the second image forming unit includes a biasing member, and

wherein the biasing member biases the second developing unit so that the second developing roller contacts the second photosensitive drum.

**10**. The image forming apparatus according to claim **1**, wherein the first image forming unit is arranged adjacent to the second image forming unit.

**11**. An image forming apparatus comprising:

a first image forming unit having a first drum unit including a first photosensitive drum, and a first developing unit including a first developing roller configured to contact the first photosensitive drum;

a second image forming unit having a second drum unit including a second photosensitive drum, and a second developing unit including a second developing roller configured to contact the second photosensitive drum;

a first movement mechanism configured to move the first developing unit so that the first developing unit is located at a first contact position where the first developing roller contacts the first photosensitive drum, and a first separation position where the first developing roller is separate from the first photosensitive drum;

a second movement mechanism configured to move the second developing unit so that the second developing unit is located at a second contact position where the second developing roller contacts the second photosensitive drum, a second separation position where the second developing roller is separate from the second photosensitive drum, and an intermediate position between the second contact position and the second separation position; and

a control unit configured to execute a first image forming operation in a state where the first developing roller contacts the first photosensitive drum, and the second developing roller is separate from the second photosensitive drum,

wherein the control unit is configured to execute the first image forming operation in a state where the second developing unit is located at the intermediate position.

**12**. The image forming apparatus according to claim **11**, further comprising a third image forming unit having a third photosensitive drum, and a third developing unit including a third developing roller configured to contact the third photosensitive drum,

wherein the control unit is configured to execute the first image forming operation in a state where the third developing roller is separate from the third photosensitive drum.

**13**. The image forming apparatus according to claim **12**, further comprising a third movement mechanism configured to move the third developing unit so that the third developing unit is located at a third contact position where the third developing roller contacts the third photosensitive drum, a third separation position where the third developing roller is separate from the third photosensitive drum, and an intermediate position between the third contact position and the third separation position,

wherein the control unit is configured to execute the first image forming operation in a state where the third developing unit is located at the intermediate position between the third contact position and the third separation position.

**14**. The image forming apparatus according to claim **11**,

wherein the second movement mechanism includes a movement member configured to come into contact with the second developing unit, a cam portion configured to rotate, and a coupling portion configured to couple the movement member and the cam portion, and

wherein the cam portion includes a first cam surface and a second cam surface, and when the coupling portion comes into contact with the first cam surface, the second developing unit is located at the second separation position, and when the coupling portion comes into contact with the second cam surface, the second developing unit is located at the intermediate position between the second contact position and the second separation position.

**15**. The image forming apparatus according to claim **14**, wherein the second cam surface has an arc shape.

**16**. The image forming apparatus according to claim **15**, wherein a center of the arc shape coincides with a rotation center of the cam portion.

**17**. The image forming apparatus according to claim **14**, wherein the second movement mechanism includes a biasing member configured to bias the movement member toward the second developing unit.

**18**. The image forming apparatus according to claim **11**,

wherein the second image forming unit includes a biasing member, and

wherein the biasing member biases the second developing unit so that the second developing roller contacts the second photosensitive drum.

**19**. The image forming apparatus according to claim **11**, wherein the first image forming unit is arranged adjacent to the second image forming unit.

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